SCIENCE

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CONTENTS

The British Association for the Advancement of Science:—

The Place of Pure Mathematics: DR. H. F. BAKER 347

Work going on at Kilauea Volcano: GEO. CARROLL CURTIS 355

Scientific Notes and News 358

University and Educational News 361

Discussion and Correspondence:—

A Peculiar Dermal Element in Chimæroid Fishes: T. D. A. COCKERELL. *Labeling Microscopic Slides:* ERNEST SHAW REYNOLDS. *Upon the Distribution of Rhodochytrium:* JOHN G. HALL 363

Scientific Books:—

Mann on the Teaching of Physics: PROFESSOR F. E. KESTER. *Baker on Thick Lens Optics; Thorington on Prisms:* DR. P. G. NUTTING 365

Special Articles:—

A Parasite of the Chinch-bug Egg: JAMES W. MCCOLLOCH. *Some Observations on the Sexuality of Spirogyra:* DR. HARLAN H. YORK 367

The Society of American Bacteriologists:—

Systematic and Physiologic Bacteriology; Dairy Bacteriology: DR. A. PARKER HITCHENS 369

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THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE PLACE OF PURE MATHEMATICS[1]

IT is not a very usual thing for the opening address of this section to be entrusted to one whose main energies have been devoted to what is called pure mathematics; but I value the opportunity in order to try to explain what, as I conceive it, the justification of the pure mathematician is. You will understand that in saying this I am putting myself in a position which belongs to me as little by vocation as by achievement, since it was my duty through many years to give instruction in all the subjects usually regarded as mathematical physics, and it is still my duty to be concerned with students in these subjects. But my experience is that the pure mathematician is apt to be regarded by his friends as a trifler and a visionary, and the consciousness of this becomes in time a paralyzing deadweight. I think that view is founded on want of knowledge.

Of course, it must be admitted that the mathematician, as such, has no part in those public endeavors that arise from the position of our empire in the world, nor in the efforts that must constantly be made for social adjustment at home. I wish to make this obvious remark. For surely the scientific man must give his time and his work in the faith of at least an intellectual harmony in things; and he must wish to know what to think of all that seems out of gear in the working of human relations. His

[1] Address of the president to the Mathematical and Physical Science Section of the British Association for the Advancement of Science, Birmingham, 1913.

own cup of contemplation is often golden; he marks that around him there is fierce fighting for cups that are earthen, and largely broken; and many there are that go thirsting. And, again, the mathematician is as sensitive as others to the marvel of each recurring springtime, when, year by year, our common mother seems to call us so loudly to consider how wonderful she is, and how dependent we are, and he is as curious as to the mysteries of the development of living things. He can draw inspiration for his own work, as he views the spectacle of a starry night, and sees

> How the floor of heaven
> Is thick inlaid with patines of bright gold.
> Each orb, the smallest, in his motion, sings,

but the song, once so full of dread, how much it owes to the highest refinements of his craft, from at least the time of the Greek devotion to the theory of conic sections; how much, that is, to the harmony that is in the human soul. Yet the mathematician bears to the natural observer something of the relation which the laboratory botanist has come to bear to the field naturalist. Moreover, he is shut off from inquiries which stir the public imagination; when he looks back the ages over the history of his own subject the confidence of his friends who study heredity and teach eugenics arouses odd feelings in his mind; if he feels the fascination which comes of the importance of such inquiries, he is also prepared to hear that the subtlety of nature grows with our knowledge of her. Doubtless, too, he wishes he had some participation in the discovery of the laws of wireless telegraphy, or had something to say in regard to the improvement of internal-combustion engines or the stability of aeroplanes; it is little compensation to remember, though the mathematical physicist is his most tormenting critic, what those of his friends who have the physical instinct used to say on the probable development of these things, however well he may recall it.

But it is not logical to believe that they who are called visionary because of their devotion to creatures of the imagination can be unmoved by these things. Nor is it at all just to assume that they are less conscious than others of the practical importance of them, or less anxious that they should be vigorously prosecuted.

Why is it, then, that their systematic study is given to other things, and not of necessity, and in the first instance, to the theory of any of these concrete phenomena? This is the question I try to answer. I can only give my own impression, and doubtless the validity of an answer varies as the accumulation of data, made by experimenters and observers, which remains unutilized at any time.

The reason, then, is very much the same as that which may lead a man to abstain from piecemeal, indiscriminate charity in order to devote his attention and money to some well-thought-out scheme of reform which seems to have promise of real amelioration. One turns away from details and examples, because one thinks that there is promise of fundamental improvement of methods and principles. This is the *argumentum ad hominem*. But there is more than that. The improvement of general principles is arduous, and if undertaken only with a view to results may be ill-timed and disappointing. But as soon as we consciously give ourselves to the study of universal methods for their own sake another phenomenon appears. The mind responds, mastery of the relations of things, hitherto unsuspected, begin to appear on the mental horizon. I am well enough aware of the retort to which such a statement is open. But, I say, interpret the fact as you will, our intellectual pleasure in life cometh not by might nor by power—arises, that is,

most commonly, not of set purpose—but lies at the mercy of the response which the mind may make to the opportunities of its experience. When the response proves to be of permanent interest—and for how many centuries have mathematical questions been a fascination?—we do well to regard it. Let us compare another case which is, I think, essentially the same. It may be that early forms of what now is specifically called art arose with a view to applications: I do not know. But no one will deny that art, when once it has been conceived by us, is a worthy object of pursuit; we know by a long trial that we do wisely to yield ourselves to a love of beautiful things, and to the joy of making them. Well, pure mathematics, as such, *is* an art, a creative art. If its past triumphs of achievement fill us with wonder, its future scope for invention is exhaustless and open to all. It is also a science. For the mind of man is one: to scale the peaks it spreads before the explorer is to open ever new prospects of possibility for the formulation of laws of nature. Its resources have been tested by the experience of generations; to-day it lives and thrives and expands and wins the life-service of more workers than ever before.

This, at least, is what I wanted to say, and I have said it with the greatest brevity I could command. But may I dare attempt to carry you further? If this seems fanciful, what will you say to the setting in which I would wish to place this point of view? And yet I feel bound to try to indicate something more, which may be of wider appeal. I said a word at starting as to the relations of science to those many to whom the message of our advanced civilization is the necessity, above all things, of getting bread. Leaving this aside, I would make another reference. In our time old outlooks have very greatly changed; old hopes, disregarded perhaps because undoubted, have very largely lost their sanction, and given place to earnest questionings. Can any one who watches doubt that the courage to live is in some danger of being swallowed up in the anxiety to acquire? May it not be, then, that it is good for us to realize, and to confess, that the pursuit of things that are beautiful, and the achievement of intellectual things that bring the joy of overcoming, is at least as demonstrably justifiable as the many other things that fill the lives of men? May it not be that a wider recognition of this would be of some general advantage at present? Is it not even possible that to bear witness to this is one of the uses of the scientific spirit? Moreover, though the pursuit of truth be a noble aim, is it so new a profession; are we so sure that the ardor to set down all the facts without extenuation is, unassisted, so continuing a purpose? May science itself not be wise to confess to what is its own sustaining force?

Such, ladies and gentlemen, in crude, imperfect phrase, is the *apologia*. If it does not differ much from that which workers in other ways would make, it does, at least, try to represent truly one point of view, and it seems to me specially applicable to the case of pure mathematics. But you may ask: What, then, is this subject? What can it be about if it is not primarily directed to the discussion of the laws of natural phenomena? What kind of things are they that can occupy alone the thoughts of a lifetime? I propose now to attempt to answer this, most inadequately, by a bare recital of some of the broader issues of present interest—though this has difficulties, because the nineteenth century was of unexampled fertility in results and suggestions, and I must be as little technical as possible.

PRECISION OF DEFINITIONS

First, in regard to two matters which illustrate how we are forced by physical problems into abstract inquiries. It is a constantly recurring need of science to reconsider the exact implication of the terms employed; and as numbers and functions are inevitable in all measurement, the precise meaning of number, of continuity, of infinity, of limit, and so on, are fundamental questions; those who will receive the evidence can easily convince themselves that these notions have many pitfalls. Such an imperishable monument as Euclid's theory of ratio is a familiar sign that this has always been felt. The last century has witnessed a vigorous inquiry into these matters, and many of the results brought forward appear to be new; nor is the interest of the matter by any means exhausted. I may cite, as intelligible to all, such a fact as the construction of a function which is continuous at all points of a range, yet possesses no definite differential coefficient at any point. Are we sure that human nature is the only continuous variable in the concrete world, assuming it be continuous, which can possess such a vacillating character? Or I may refer to the more elementary fact that all the rational fractions, infinite in number, which lie in any given range, can be enclosed in intervals whose aggregate length is arbitrarily small. Thus we could take out of our life all the moments at which we can say that our age is a certain number of years, and days, and fractions of a day, and still have appreciably as long to live; this would be true, however often, to whatever exactness, we named our age, provided we were quick enough in naming it. Though the recurrence of these inquiries is part of a wider consideration of functions of complex variables, it has been associated also with the theory of those series which Fourier used so boldly, and so wickedly, for the conduction of heat. Like all discoverers, he took much for granted. Precisely how much is the problem. This problem has led to the precision of what is meant by a function of real variables, to the question of the uniform convergence of an infinite series, as you may see in early papers of Stokes, to new formulation of the conditions of integration and of the properties of multiple integrals, and so on. And it remains still incompletely solved.

CALCULUS OF VARIATIONS

Another case in which the suggestions of physics have caused grave disquiet to the mathematicians is the problem of the variation of a definite integral. No one is likely to underrate the grandeur of the aim of those who would deduce the whole physical history of the world from the single principle of least action. Every one must be interested in the theorem that a potential function, with a given value at the boundary of a volume, is such as to render a certain integral, representing, say, the energy, a minimum. But in that proportion one desires to be sure that the logical processes employed are free from objection. And, alas! to deal only with one of the earliest problems of the subject, though the finally sufficient conditions for a minimum of a simple integral seemed settled long ago, and could be applied, for example, to Newton's celebrated problem of the solid of least resistance, it has since been shown to be a general fact that such a problem can not have any definite solution at all. And, although the principle of Thomson and Dirichlet, which relates to the potential problem referred to, was expounded by Gauss, and accepted by Riemann, and remains to-day in our standard treatise on National Philosophy, there can be no doubt that, in the form in which it was originally

stated, it proves just nothing. Thus a new investigation has been necessary into the foundations of the principle. There is another problem, closely connected with this subject, to which I would allude: the stability of the solar system. For those who can make pronouncements in regard to this I have a feeling of envy; for their methods, as yet, I have a quite other feeling. The interest of this problem alone is sufficient to justify the craving of the pure mathematician for powerful methods and unexceptionable rigor.

NON-EUCLIDIAN GEOMETRY

But I turn to another matter. It is an old view, I suppose, that geometry deals with facts about which there can be no two opinions. You are familiar with the axiom that, given a straight line and a point, one and only one straight line can be drawn through the point parallel to the given straight line. According to the old view the natural man would say that this is either true or false. And, indeed, many and long were the attempts made to justify it. At length there came a step which to many probably will still seem unintelligible. A system of geometry was built up in which it is assumed that, given a straight line and a point, an infinite number of straight lines can be drawn through the point, in the plane of the given line, *no one* of which meets the given line. Can there then, one asks at first, be two systems of geometry, both of which are true, though they differ in such an important particular? Almost as soon believe that there can be two systems of laws of nature, essentially differing in character, both reducing the phenomena we observe to order and system—a monstrous heresy, of course! I will only say that, after a century of discussion we are quite sure that many systems of geometry are possible, and true; though not all may be expedient. And if you reply that a geometry is useful for life only in proportion as it fits the properties of concrete things, I will answer, first, are the heavens not then concrete? And have we as yet any geometry that enables us to form a consistent logical idea of furthermost space? And, second, that the justification of such speculations is the interest they evoke, and that the investigations already undertaken have yielded results of the most surprising interest.

THE THEORY OF GROUPS

To-day we characterize a geometry by the help of another general notion, also, for the most part, elaborated in the last hundred years, by means of its group. A group is a set of operations which is closed, in the same sense that the performance of any two of these operations in succession is equivalent to another operation of the set, just as the result of two successive movements of a rigid body can be achieved by a single movement. One of the earliest conscious applications of the notion was in the problem of solving algebraic equations by means of equations of lower order. An equation of the fourth order can be solved by means of a cubic equation, because there exists a rational function of the four roots which takes only three values when the roots are exchanged in all possible ways. Following out this suggestion for an equation of any order, we are led to consider, taking any particular rational function of its roots, what is the group of interchanges among them which leaves this function unaltered in value. This group characterizes the function, all other rational functions unaltered by the same group of interchanges being expressible rationally in terms of this function. On these lines a complete theory of equations which are soluble algebraically can be given. Any

one who wishes to form some idea of the richness of the landscape offered by pure mathematics might do worse than make himself acquainted with this comparatively small district of it. But the theory of groups has other applications. It may be interesting to refer to the circumstance that the group of interchanges among four quantities which leave unaltered the product of their six differences is exactly similar to the group of rotations of a regular tetrahedron whose center is fixed, when its corners are interchanged among themselves. Then I mention the historical fact that the problem of ascertaining when that well-known linear differential equation called the hypergeometric equation has all its solutions expressible in finite terms as algebraic functions, was first solved in connection with a group of similar kind. For any linear differential equation it is of primary importance to consider the group of interchanges of its solutions when the independent variable, starting from an arbitrary point, makes all possible excursions, returning to its initial value. And it is in connection with this consideration that one justification arises for the view that the equation can be solved by expressing both the independent and dependent variables as single-valued functions of another variable. There is, however, a theory of groups different from those so far referred to, in which the variables can change continuously; this alone is most extensive, as may be judged from one of its lesser applications, the familiar theory of the invariants of quantics. Moreover, perhaps the most masterly of the analytical discussions of the theory of geometry has been carried through as a particular application of the theory of such groups.

THE THEORY OF ALGEBRAIC FUNCTIONS

If the theory of groups illustrates how a unifying plan works in mathematics beneath bewildering detail, the next matter I refer to well shows what a wealth, what a grandeur, of thought may spring from what seem slight beginnings. Our ordinary integral calculus is well-nigh powerless when the result of integration is not expressible by algebraic or logarithmic functions. The attempt to extend the possibilities of integration to the case when the function to be integrated involves the square root of a polynomial of the fourth order, led first, after many efforts, among which Legendre's devotion of forty years was part, to the theory of doubly-periodic functions. To-day this is much simpler than ordinary trigonometry, and, even apart from its applications, it is quite incredible that it should ever again pass from being among the treasures of civilized man. Then, at first in uncouth form, but now clothed with delicate beauty, came the theory of general algebraical integrals, of which the influence is spread far and wide; and with it all that is systematic in the theory of plane curves, and all that is associated with the conception of a Riemann surface. After this came the theory of multiply-periodic functions of any number of variables, which, though still very far indeed from being complete, has, I have always felt, a majesty of conception which is unique. Quite recently the ideas evolved in the previous history have prompted a vast general theory of the classification of algebraical surfaces according to their essential properties, which is opening endless new vistas of thought.

THEORY OF FUNCTIONS OF COMPLEX VARIABLES: DIFFERENTIAL EQUATIONS

But the theory has also been prolific in general principles for functions of complex variables. Of greater theories, the problem of automorphic functions alone is a

vast continent still largely undeveloped, and there is the incidental problem of the possibilities of geometry of position in any number of dimensions, so important in so many ways. But, in fact, a large proportion of the more familiar general principles, taught to-day as theory of functions, have been elaborated under the stimulus of the foregoing theory. Besides this, however, all that precision of logical statement of which I spoke at the beginning is of paramount necessity here. What exactly is meant by a curve of integration, what character can the limiting points of a region of existence of a function possess, how even best to define a function of a complex variable, these are but some obvious cases of difficulties which are very real and pressing to-day. And then there are the problems of the theory of differential equations. About these I am at a loss what to say. We give a name to the subject, as if it were one subject, and I deal with it in the fewest words. But our whole physical outlook is based on the belief that the problems of nature are expressible by differential equations; and our knowledge of even the possibilities of the solutions of differential equations consists largely, save for some special types, of that kind of ignorance which, in the nature of the case, can form no idea of its own extent. There are subjects whose whole content is an excuse for a desired solution of a differential equation; there are infinitely laborious methods of arithmetical computation held in high repute of which the same must be said. And yet I stand here to-day to plead with you for tolerance of those who feel that the prosecution of the theoretic studies, which alone can alter this, is a justifiable aim in life! Our hope and belief is that over this vast domain of differential equations the theory of functions shall one day rule, as already it largely does, for example, over linear differential equations.

THEORY OF NUMBERS

In concluding this table of contents, I would also refer, with becoming brevity, to the modern developments of theory of numbers. Wonderful is the fascination and the difficulty of these familiar objects of thought—ordinary numbers. We know how the great Gauss, whose lynx eye was laboriously turned upon all the physical science of his time, has left it on record that in order to settle the law of a plus or minus sign in one of the formulæ of his theory of numbers he took up the pen every week for four years. In these islands perhaps our imperial necessities forbid the hope of much development of such a theoretical subject. But in the land of Kummer and Gauss and Dirichlet the subject to-day claims the allegiance of many eager minds. And we can reflect that one of the latest triumphs has been with a problem known by the name of our English senior wrangler, Waring—the problem of the representation of a number by sums of powers.

Ladies and gentlemen, I have touched only a few of the matters with which pure mathematics is concerned. Each of those I have named is large enough for one man's thought; but they are interwoven and interlaced in indissoluble fashion and form one mighty whole, so that to be ignorant of one is to be weaker in all. I am not concerned to depreciate other pursuits, which seem at first sight more practical; I wish only, indeed, as we all do, it were possible for one man to cover the whole field of scientific research; and I vigorously resent the suggestion that those who follow these studies are less careful than others of the urgent needs of our national life. But

pure mathematics is not the rival, even less is it the handmaid, of other branches of science. Properly pursued, it is the essence and soul of them all. It is not for them; they are for it; and its results are for all time. No man who has felt its fascination can be content to be ignorant of any manifestation of regularity and law, or can fail to be stirred by all the need of adjustment of our actual world.

And if life is short, if the greatest magician, joining with the practical man, reminds us that, like this vision,

> The cloud-capp'd towers, the gorgeous palaces,
> The solemn temples, the great globe itself,
> Yea, all which it inherit, shall dissolve
> And . . . leave not a rack behind,

we must still believe that it is best for us to try to reach the brightest light. And all here must believe it; for else—no fact is more firmly established—we shall not study science to any purpose.

But that is not all I want to say, or at least to indicate. I have dealt so far only with proximate motives; to me it seems demonstrable that a physical science that is conscientious requires the cultivation of pure mathematics; and the most mundane of reasons seem to me to prompt the recognition of the esthetic outlook as a practical necessity, not merely a luxury, in a successful society. Nor do I want to take a transcendental ground. Every schoolboy, I suppose, knows the story of the child born so small, if I remember aright, that he could be put into a quart pot, in a farmhouse on the borders of Lincolnshire—it was the merest everyday chance. By the most incalculable of luck his brain-stuff was so arranged, his parts so proportionately tempered, that he became Newton, and taught us the laws of the planets. It was the blindest concurrence of physical circumstances; and so is all our life. Matter in certain relations to itself, working by laws we can examine in the chemical laboratory, produces all these effects, produces even that state of brain which accompanies the desire to speak of the wonder of it all. And the same laws will inevitably hurl all into confusion and darkness again; and where will all our joys and fears, and all our scientific satisfaction, be then?

As students of science, we have no right to shrink from this point of view; we are pledged to set aside prepossession and dogma, and examine what seems possible, wherever it may lead. Even life itself may be mechanical, even the greatest of all things, even personality, may some day be resoluble into the properties of dead matter, whatever that is. We can all see that its coherence rises and falls with illness and health, with age and physical conditions. Nor, as it seems to me, can anything but confusion of thought arise from attempts to people our material world with those who have ceased to be material.

An argument could perhaps be based on the divergence, as the mathematician would say, of our comprehension of the properties of matter. For though we seem able to summarize our past experiences with ever-increasing approximation by means of fixed laws, our consciousness of ignorance of the future is only increased thereby. Do we feel more, or *less,* competent to grasp the future possibilities of things, when we can send a wireless message 4,000 miles, from Hanover to New Jersey?

Our life is begirt with wonder, and with terror. Reduce it by all means to ruthless mechanism, *if you can;* it will be a great achievement. But it can make no sort of difference to the fact that the things for which we live are spiritual. The rose is no less sweet because its sweetness is conditioned by the food we supply to its roots.

It is an obvious fact, and I ought to apologize for remarking it, were it not that so much of our popular science is understood by the haste to imply an opposite conclusion. If a chemical analysis of the constituents of sea-water could take away from the glory of a mighty wave breaking in the sunlight, it would still be true that it was the mind of the chemist which delighted in finding the analysis. Whatever be its history, whatever its physical correlations, it is an undeniable fact that the mind of man has been evolved; I believe that is the scientific word. You may speak of a continuous upholding of our material framework from without; you may ascribe fixed qualities to something you call matter; or you may refuse to be drawn into any statement. But anyway, the fact remains that the precious things of life are those we call the treasures of the mind. Dogmas and philosophies, it would seem, rise and fall. But gradually accumulating throughout the ages, from the earliest dawn of history, there is a body of doctrine, a reasoned insight into the relations of exact ideas, painfully won and often tested. And this remains the main heritage of man; his little beacon of light amidst the solitudes and darknesses of infinite space; or, if you prefer, like the shout of children at play together in the cultivated valleys, which continues from generation to generation.

Yes, and continues for ever! A universe which has the potentiality of becoming thus conscious of itself is not without something of which that which we call memory is but an image. Somewhere, somehow, in ways we dream not of, when you and I have merged again into the illimitable whole, when all that is material has ceased, the faculty in which we now have some share shall surely endure; the conceptions we now dimly struggle to grasp, the joy we have in the effort, these are but part of a greater whole. Some may fear, and some may hope, that they and theirs shall not endure for ever. But he must have studied nature in vain who does not see that our spiritual activities are inherent in the mighty process of which we are part; who can doubt of their persistence.

And, on the intellectual side, of all that is best ascertained, and surest, and most definite, of these; of all that is oldest and most universal; of all that is most fundamental and far-reaching, of these activities, pure mathematics is the symbol and the sum.

H. F. BAKER

WORK GOING ON AT KILAUEA VOLCANO

FOR the past three months the "fires of Pelé" have been comparatively low, the conditions in the active pit of Halemaumau being that of unusual quiescence. The level of the bottom has also remained lower than at any other time since last fall, when it had a depth of about 700 feet. The last plane-table measurement obtained gave a depth of 550 feet and the subsequent change has been small.

Since its late maximum height of about 350 feet below the rim, in January of this year, the liquid lava lake has in its general movement been dropping, though a rise in June and July, 1912, presented an activity greater than any other recorded during the past thirty years. There was a molten lake 650 feet long by 450 feet wide. As many as six hundred fountains of liquid magma played simultaneously and threw the molten spray to heights of twenty to thirty feet, accompanied by a sound like the roar of heavy ocean surf. In December. after intermittent declines, the level of the lake again rose, though to a lesser altitude and accompanied with decreased activity; this condition continuing until the middle of February of this year. Since then the resultant effects have been a lowering of the surface of the lava column until, on May 1, it disappeared from all view either by day or through incandescence at night.

The lowering of the lava column was naturally accompanied by landslides due to the non-support of lower portions of the crater walls. Some of the avalanches were of considerable magnitude and duration; they gradually grew less in sound frequency and volume until, during the latter part of the month (June), they nearly ceased. Fumes and vaporous emanations have largely obscured the inner pit during the past months, and until lately the best views gained at brief intervals have shown the bottom to be largely free from molten lava. Some dozen steaming outlets surrounded with sulphurous deposits have at times revealed themselves in the bottom of the sunken well, in whose very lowest point a funnel-shaped depression descending into unknown depths has been momentarily disclosed. On the ninth of May an unusual detonation was heard toward the central portion of the pit and this has been succeeded by steam explosions resembling blasts from a locomotive's funnel. In accordance with the working hypothesis at the Hawaiian Volcano Observatory, the molten magma is due to rise on the approach of the summer solstice.

WORK AT THE VOLCANO OBSERVATORY

Since January, 1912, regular routine work has been going on in the Observatory of the Massachusetts Institute of Technology, on the very edge of the precipitous-sided caldera of Kilauea. In the Whitney Laboratory of Seismology built in the observatory cellar above steam cracks and heated from their emanations, four large seismographs are installed, including two heavy 100-kilogram Bosch-Omori trinometers, and one ordinary Omori seismograph for the registration of strong local earthquakes; and also one heavy Omori trinometer.

On May 19, Greenwich time, the heaviest shock of immediate origin yet recorded by the instruments was observed. It was felt by us at the Volcano House very distinctly, and even more at Hilo, thirty miles distant.

Ordinary microseismic motion has been constantly recorded by the instruments on the rim of the volcano's crater, and there are more rapid movements which have, in view of their obvious origin, been designated as "volcanic vibrations."[1]

On the very edge of the active Halemaumau, in the rough building of the Technology Volcano Station, a two-component Omori horizontal pendulum trinometer is installed on the concrete pier placed by the U. S. Geological Survey as a bench mark during the survey last year for the special map of the "proposed Kilauea Volcano National Park."

The instruments at the observatory will probably be connected with telephone at the brink of the lava lake, so that one standing on its very edge may correlate his observations with those being recorded two and one half miles away on the high surrounding edge of the Kilauea Sink; it will thus be possible to note the seismic effects of changes in molten magma, explosions, landslides, etc., which occur within a volcano's crater. Had such instruments been installed near the craters of Pelé and La Soufrière during the memorable 1902 eruptions they would not only have been of service to science, but in informing the distracted remnant of the populations in regard to the nature of the subsequent seismic disturbances.

Among the work being carried on under Director Jaggar are: photographic record of phases of volcanic activity, measurements of the surface of the magma column, experimental work with microphones, cinematographic registration of the activity of the molten lava, spectroscopic study of volcanic flames, optical pyrometry applied to the molten magma in the field, studies in the temperature of fumaroles and solfataras, as well as other investigations relating to the geology, mineralogy, petrography and natural history of Kilauea.

STUDIES FROM KITE PHOTOGRAPHY

In connection with the somewhat novel work now being conducted at Kilauea under

[1] H. O. Wood, *Bull. Seismo. Soc. of Am.*, Vol. III., No. 1.

the auspices of the geological department of Harvard University, of reproducing the volcano in naturalistic relief, it is proposed to make a series of aerial photographs from kites flown at heights of from one to several miles above the crater and adjacent region. Not only will the data obtained be applied to supplement the photographic survey just completed after three months of field work, itself probably the most comprehensive of its kind yet made for the reproduction of a land-form type, but it is hoped there may be secured an opportunity of novel comparison with lunar craters, which are more nearly approached by the Hawaiian type than by any others known to lie on the earth's surface. The kite photography will be conducted by expert F. W. Haworth, of Pittsburgh, who has developed this subject and pertaining apparatus to unequaled perfection.

ATTEMPT AT ACCURATE LAND RELIEF BY AMERICAN GEOLOGISTS

Primarily the purpose of the aerial photography is to furnish checks for and to supplement the data of the terrestrial, linear and photographic surveys, so that complete record of the surface forms of Kilauea will be obtained.

The aid of aerial photography in obtaining data for reproducing land in relief was employed in 1902, when the city of Washington was modeled for the U. S. Senate—views from a captive balloon—but this will probably be the first instance where kite photography has been called in to supplement the data requisite to construct a naturalistic model.

One of the oldest means employed for earth representation has naturally been actual relief, since it is the most truthful and indeed the only complete medium in which the solid world can be expressed, but strange as it may seem comparatively little attention has been given to its rational or scientific side, its aspect as a study in natural phenomena embodying for adequate treatment the observation, research and understanding which natural science demands. Thousands of diagrams in relief exist which place the arbitrarily taken points on some map into three dimensions, with little regard to the existing form and appearance of the part of the globe represented (or rather misrepresented), but they have neither been like, nor looked like, anything natural on earth. Those who understand the meaning of an ordinary map can see that the placing of its conventional data in a form of relief can never result in a true reproduction of the natural forms of earth surface, which for competent exposition must call for field observation and collection of the necessary field facts.

In the biological sciences similar procedure is well established, so that there are in our museums to-day specimens, especially of animal and plant life, which give forceful expression of the truth and vitality of the living outdoor world. Even more is there need of comparable naturalistic specimens in the earth sciences, for while most of the forms of botany and zoology are of size to be readily viewed, those of the earth's surface are so extensive and often complex that they can rarely be well comprehended in the field where frequently but a small portion of a unit is to be seen at once. Too long have geology and geography been without this unrivaled means for illustrating and forcibly interpreting the forms with which they deal, too long have the earth sciences been lacking adequate representation in the most comprehensive of all the natural arts, the one which rightly belongs to and can so richly enhance these sciences. There are signs, however, of an awakening. Men whose views have permitted seeing outside the customary methods of procedure have begun to recognize some of the need and value of the new work, and the Kilauea Crater problem now being undertaken is a result.

Kilauea Crater is situated on the island of Hawaii, American territory, within the "Proposed National Volcano Park." So new is the work of naturalistic land relief in this country that it may be said that scarcely a single American land form has been so reproduced (excellent work has already been done

in Europe and some representation of foreign types has been effected in the United States), hence the naturalistic reproduction in relief of Kilauea should mark two significant steps; first, representation in the new way of an American land-form type, and second, the entry of American geologists into this field, so useful in the promotion of their science.

Geo. Carroll Curtis
Hawaiian Volcano Observatory,
Kilauea Crater,
July, 1913

SCIENTIFIC NOTES AND NEWS

A tablet, recording the place of birth of Sir William Turner, the distinguished anatomist, principal of the University of Edinburgh, has been unveiled in his native town of Lancaster.

At the meeting of the section of tropical medicine and hygiene of the recent International Medical Congress, Sir Patrick Manson was presented with a gold plaque. It bears his portrait and on the other side an allegorical group representing science triumphing over disease in a tropical landscape.

Col. William C. Gorgas has applied for four months' leave of absence in order to accept the invitation to advise on the sanitary conditions in Johannesburg, South Africa.

Dr. Adolf Hurwitz, professor of mathematics at the Zurich Polytechnic School, has been elected a member of the Accademia dei Lincei, Rome.

Dr. Theodor Neubürger, of Frankfort, known for his contributions to hygiene and anthropology, has celebrated the sixtieth anniversary of his doctorate.

Colorado College at its last commencement conferred the honorary degree of Sc.D. on Professor Theodore D. A. Cockerell, who holds the chair of zoology in the University of Colorado.

Sir James Grant, of Ottawa, was made an honorary life member of the Canadian Medical Association at its recent meeting.

Dr. W. L. Tower, associate professor of embryology in the University of Chicago, has gone to South America to gather material for the new bionomic laboratory just completed at the university. Professor Tower has been made curator of the laboratory, which will be equipped for the study of genetics and the problems of experimental evolution.

Dr. George H. Shull, of the Station for Experimental Evolution of the Carnegie Institution, has been granted a year's leave of absence, and will spend the greater part of the year in Berlin, in study and writing. He sailed on September 12 and will participate in the Generalversammlung der Deutschen Botanischen Gesellschaft which meets in Berlin on October 5. His paper will be on "Chlorophyllfaktoren und Buntblätterigkeit bei *Lychnis dioica*."

Dr. Frederick A. Saunders, professor of physics at Syracuse University, is spending abroad a year's leave of absence. He will visit foreign laboratories and carry forward spectroscopic research in Professor Kayser's new laboratory at Bonn.

Saul Epsteen, professor of engineering mathematics at the University of Colorado, has resigned to accept the position of insurance commissioner of Colorado.

The Permanent International Eugenics Committee, which met in Paris on August 4, decided to hold the next International Congress in New York during September, 1915. Major Leonard Darwin presided, Mrs. Gotto acted as secretary, and the following countries were represented: England (Dr. Edgar Schuster), America (Dr. F. A. Woods), France (M. Lucien March), Germany (Professor A. Ploetz), Italy (Professor C. Gini), Denmark (Dr. S. Hansen), Norway (Dr. J. A. Mjöen).

Dr. M. P. Ravenel, head of the State Hygienic Laboratory, Wisconsin, presided over a session of the Fourth International Congress on School Hygiene devoted to university health. He also made an address on bovine tuberculosis at the fiftieth anniversary meeting of the American Veterinarians' Association in session in New York City, September 1–5.

DR. TEMPEST ANDERSON, an ophthalmic surgeon of York, known for his publications on earthquakes and volcanoes, died on August 20, aged sixty-nine years, while returning from the Philippine Islands.

MR. J. R. SHELDON, formerly professor of agriculture at the Royal Agricultural College, Cirencester, has died, aged seventy-three years.

ROBERT RIEDER PASHA, formerly professor of surgery at Bonn and afterwards inspector-general of medical schools in Turkey, has died at the age of fifty-one years.

THE death is announced, as the result of an accident, of Professor C. Bourlet, professor of mechanics at the Conservatoire des Arts et Métiers in Paris.

WE learn from *Nature* that by the will of Professor Emil Chr. Hansen and his wife a fund bearing his name has been established. At intervals of two or three years, beginning in 1914, a gold medal bearing his effigy and accompanied by a sum of at least 2,000 kroner is to be awarded on May 8 to the author of a meritorious publication on some microbiological subject, and recently published in Denmark or elsewhere. In 1914 the medal will be awarded to a worker in the field of medical microbiology. The president of the board of trustees is Professor S. P. L. Sorensen, the chemical department of Carlsberg Laboratory, Copenhagen, from whom all information may be obtained.

PROVISION has been made for the establishment of a national museum by the Dominican government in the city of Santo Domingo for the purpose of retaining and preserving in the country objects and relics of historical character connected with the discovery and development of the country. The museum is to be established in the old palace known as the house of Don Diego Colon. The sum of $20,000 has been appropriated by the National Congress for repairing the building.

THE Field Museum of Natural History has arranged its thirty-ninth free lecture course on science and travel for Saturday afternoons, at three o'clock, as follows:

October 4—"Korea," Mr. Homer B. Hulbert, Springfield, Mass.

October 11—"The Scenery and Resources of Alaska," Professor Lawrence Martin, University of Wisconsin.

October 18—"The Physical Basis and Determination of Sex," Dr. Horatio H. Newman, the University of Chicago.

October 25—"Our Forests," Mr. Huron H. Smith, assistant curator of dendrology.

November 1—"Zoological Collecting in South America," Mr. Wilfred H. Osgood, assistant curator of mammalogy and ornithology.

November 8—"The Inhabitants of Fresh Water," Dr. Victor E. Shelford, the University of Chicago.

November 15—"Migration of Plants," Professor L. H. Pammel, Iowa State College.

November 22—"The Joseph N. Field South Pacific Expedition," Dr. A. B. Lewis, assistant curator of African and Melanesian ethnology.

November 29—"New Zealand," Dr. Carlos E. Cummings, Buffalo Society of Natural Sciences.

THE Macbride Lakeside Laboratory, located on West Lake Okoboji, Iowa, has just closed its most successful session, under the direction of Professor Thomas H. Macbride. Courses were offered in botany, zoology and geology, special emphasis being placed on field work. The laboratory was established in 1909 by the alumni of the State University of Iowa, and was named in honor of its director. It is affiliated with the colleges of the state through the state university, and is devoted to research by special students and teachers of the natural sciences. The work was in charge of the following staff: Professor Thomas H. Macbride, University of Iowa, and Mr. A. F. Ewers, McKinley High School, St. Louis, botany; Dr. T. C. Stephens, Morningside College, general zoology and ornithology; Professor J. C. Carman, University of Cincinnati, geology; Professor C. E. Bartholomew, Ames, entomology. Special series of lectures were given by Dr. Lynds Jones, of Oberlin, on ornithology, and by Professor L. H. Pammel, of Ames, on plant diseases.

It is stated in *Nature* that the Institut International de Physique Solvay has a sum of 20,000 francs available for the encouragement of experimental work in physics and physical chemistry, particularly for investigations on radiation phenomena and for studies of the theory of energy quanta and of molecular theories. Grants from the fund will be awarded, without distinction of nationality, by the administrative commission of the institute on the recommendation of the international scientific committee. The administrative commission is composed of Professors P. Heger, E. Tassel and J. E. Verschaffelt, Brussels, and the scientific committee of M. H. A. Lorentz, president, Haarlem; Mme. M. Curie, Paris; M. Brillouin, Paris; R. B. Goldschmidt, Brussels; H. Kamerlingh-Onnes, Leyden; W. Nernst, Berlin; E. Rutherford, Manchester; E. Warburg, Berlin, and M. Knudsen, secretary, Copenhagen. Applications for grants should be made before September 15 to Professor H. A. Lorentz, Zijlweg 76, Haarlem, Holland.

Six million acres of withdrawn public lands were restored to entry during the months of May and June upon approval by the Secretary of the Interior of the recommendations of the U. S. Geological Survey. This action was the result of examination and classification of the lands by the survey, those restored either having been found not to be valuable for power sites, reservoirs, coal, phosphate or potash deposits, or having been definitely valued as coal lands, and rendered available for purchase under the coal-land law. Of these lands relieved from coal withdrawal nearly two and a half million acres were in the state of Colorado. Five and a half thousand acres were also withdrawn in Colorado as water-power sites. In Idaho 1,100,000 acres of coal and phosphate withdrawals were classified and restored, and for water-power sites approximately 10,000 acres were withdrawn and about the same acreage restored. In Montana 250,000 acres were restored as being noncoal-bearing and about 1,000 acres as not valuable for water-power sites, while about 150 acres were withdrawn for that purpose. In North Dakota nearly 1,400,000 acres in coal withdrawal were classified and restored. In Oregon approximately 75,000 acres were restored as non-oil-bearing lands and about 12,000 acres were withdrawn for water-power or reservoir sites. In South Dakota over 330,000 acres were relieved from the coal withdrawal. In Utah about 1,500 acres were withdrawn for water-power sites. In Wyoming over 47,000 acres of coal withdrawals were reopened to entry and purchase; approximately 87,000 acres were withdrawn for classification as to whether they are oil-bearing lands, and about 304,000 acres were restored as nonphosphate lands. For all states the total withdrawals during the months of May and June were over 116,000 acres, and the total restorations were over 6,000,000 acres. The total outstanding withdrawals on July 1 in all the public-land states amounted to 68,609,289 acres, of which more than fifty-eight million acres are in coal-land withdrawals. These lands are held pending classification by the Geological Survey, and as rapidly as they are found to be mineral bearing they are either valued and placed on sale (as in the case of coal lands), definitely reserved pending appropriate legislation by congress to provide for their disposition (as in the case of potash or phosphate lands), or held subject to development under departmental regulations (as in the case of water power or reservoir reservations); or if they are found to be nonmineral in character they are restored to public entry. This work of classification and valuation is being prosecuted by the Geological Survey as rapidly as the appropriations provided by congress will permit.

The report of the Royal Commission on Industrial Training and Technical Education in Canada, instituted three years ago, has now been made public. According to foreign journals the report suggests that a fund of £600,000 be provided annually by the Dominion for a period of ten years, and be divided among the provinces on the basis of population for the promotion of higher technical education and industrial training, while for elementary

schools teaching manual training and domestic science a grant of £70,000 a year for ten years is recommended. The report also proposes the establishment in each province of a board qualified to carry on industrial training. It advocates the provision of suitable and adequate apparatus and equipment for teaching purposes, the foundation of scholarships for students, the engagement of experts with experience in industrial training, and the creation of central institutions to supplement the work carried on by the provincial and local authorities. Workers in factories whose main task is to attend or to operate machines should, it is suggested, receive instruction which would develop all-round skill and increase their interest beyond the routine of automatic operations. Such training should be provided as will conserve and develop occupations in which skilled handicraft is required. The interests of the rural population should be preserved so far as possible by industrial training and technical education suitable to the needs of its workers. The needs of girls and women for organized instruction and training in housekeeping and home-making under modern industrial conditions should be recognized. The report also recommends that schools for fishermen should be established, and that provision be made for instruction in packing and curing. The distinguishing characteristic of the report is the attention which it gives to the problems of the rural communities.

THE U. S. Geological Survey has just issued, as an advance chapter from "Mineral Resources of the United States," a report by Alfred H. Brooks on the mine production of precious and semi-precious metals in Alaska in 1912. Metalliferous mining in Alaska, says Mr. Brooks, made important advances last year. Although the output of gold placers was less than in 1911, the installation of large plants, notably of dredges, in many districts is encouraging for the future of this industry. More important was the progress made in lode gold mining, the output of which was greater than in previous years. Copper mining also advanced, partly because several large plants increased their output, partly because a number of small mines were developed on account of the high price of copper. The development of the coal fields still awaits the establishment of a definite policy in regard to the disposition of the public coal lands. The delay in securing cheap fuel for the territory has now for many years caused a stagnation in many industries. Railway construction and, to a certain extent, railway operation have stopped and many mining enterprises have been hampered if not entirely abandoned on account of the uncertainty as to the fuel problem. Very few Alaskans have any direct interest in coal claims or in mining, but the entire population of the territory is desirous of seeing the coal fields developed, because it is believed that this will bring about advancement in many other industries. Above all, it will encourage the operation and the construction of railways, which are all important to the territory. The total mine production of gold, silver and copper in Alaska in 1912 was valued at $22,285,821, against $20,505,664 in 1911, an increase of $1,780,158. The value of the gold production of Alaska last year is estimated at $17,145,951, that of silver at $316,839. The copper output of Alaska for 1912 was 29,230,491 pounds, valued at $4,823,031, an increase from 1911 of 1,962,613 pounds.

UNIVERSITY AND EDUCATIONAL NEWS

THE Florida legislature has made the following appropriations for the support and maintenance of the state institutions for higher education for the coming biennium: For the University of Florida at Gainesville, $173,500, which includes $30,000 for new law building, $23,000 for farmers' institutes and publishing bulletins, $15,000 for laboratory equipment and farm buildings for college of agriculture, $10,000 for equipment and machinery for college of engineering, $7,000 for heating plant to supply five new buildings; $5,000 for sewerage and disposal system. For the Florida State College for Women at Tallahassee, $148,000, of which $30,000 is for dining hall and equipment, $5,000 for domestic

science and women's institutes. For the Florida School for the Deaf and Blind, at St. Augustine, $85,000. For the Florida Agricultural and Mechanical College for Negroes, at Tallahassee, $24,000. For expenses of board of control, $5,500. Total, $436,000.

It is reported from Melbourne that a pioneer colonist, Mr. W. Robbie, has bequeathed £30,000 to Aberdeen University to establish scholarships.

A public bequest amounting to £750,000 has been made by the will of Sir William Dunn. They include £2,000 to the institute of medical science of the University of London, and £2,000 to the London School of Economics.

The registration for the year of students in regular courses at the University of California will exceed 5,300. If the summer session students be counted in, then the year's registration will exceed 8,000. Of American universities, only Columbia is larger. The enrollment at Berkeley up to the second day of registration was 4,645, or 660 more than on the corresponding date of last year. Of the 4,645 there were 1,500 new undergraduates, and, of these 1,500 new undergraduates, 1,300 were freshmen. The graduate students numbered 531, or eighteen per cent. more than on a corresponding date last year.

Ohio State University has introduced an apprentice course in animal husbandry that includes two years study at the university and two years of practical work on a stock farm. The student in this course spends the first year at the university; the second on a stock farm; the third year at the university again, and the fourth year on another stock farm. The students are paid for their work while on the farm. The plan has interested a number of the leading stock men of Ohio and other states, and they are cooperating with the university in carrying it out.

In the reorganized faculty of medicine of the University of Illinois appointments have been made as follows: Dr. Albert C. Eycleshymer, St. Louis, professor of anatomy and head of the department of anatomy of the medical school; Dr. Richard Rupert, Chicago, instructor of anatomy; Dr. George P. Dreyer, Chicago, professor of physiology and head of the department of physiology, school of medicine; Dr. Bernard Fantus, Chicago, professor of pharmacology; Dr. Edgar Grim Miller, Columbia, Pa.; Dr. J. Craig Small, Chambersburg, Pa., and Dr. H. N. Walker, Harrisburg, Pa., assistant professors of physiologic chemistry; Dr. Edgar D. Coolidge, Chicago, professor of materia medica and therapeutics.

Professor Clark W. Chamberlain has resigned the professorship of physics at Vassar College to accept the presidency of Denison University.

Professor A. L. Melander, head of the department of entomology and zoology at the Washington State College, Pullman, and entomologist of the State Experiment Station, has been granted a year's leave of absence for research work at Harvard University. Professor W. T. Shaw, zoologist and curator of the museum, will be acting head during the coming year. Mr. M. A. Yothers, assistant entomologist, will have charge of entomological investigations. Mr. E. O. Ellis, of the Iowa Agricultural College, has been elected to the position of instructor in entomology in the college and assistant in entomology in the Experiment Station.

Dr. J. E. Wodsedalek, of the zoological department of the University of Wisconsin, has been appointed professor of zoology and head of the department of zoology and entomology at the University of Idaho, Moscow, Idaho, succeeding Dr. J. M. Aldrich.

Mr. Wm. S. Aldrich, of the Reclamation Service, has been appointed acting professor of electrical and mechanical engineering at the University of Arizona, during the sabbatical leave of absence of Professor W. W. Henley.

Dr. Christian A. Ruckmick, of Cornell University, has been appointed instructor in psychology in the University of Illinois.

Professor W. H. Young, Sc.D., F.R.S., professor of mathematics in Liverpool University, has been appointed Hardinge professor of

mathematics in the University of Calcutta, for the purpose of organizing there a new school of higher mathematics. As the duties of the post require his residence in India only from November to March, it has been arranged that he shall retain his professorship in Liverpool University.

MR. HAROLD PEALING, Liverpool, has been appointed lecturer in physics in the South African College, Cape Town.

DR. ALEXANDER TORNQUIST, of Königsberg, has been invited to the chair of geology and paleontology at Leipzig.

PROFESSOR HIS, of Berlin, who was asked to accept the appointment of director of the medical clinic, at Vienna, as successor of Professor von Noorden, has declined.

DISCUSSION AND CORRESPONDENCE

A PECULIAR DERMAL ELEMENT IN CHIMÆROID FISHES

WHEN recently in Washington, I was kindly allowed by Dr. Hugh M. Smith to examine the type of *Chimæra deani* Smith and Radcliffe (Philippine Islands), to see if I could discover any scale-like dermal structures hitherto unreported. Gently scraping the side of the animal, I readily procured a number of small scale-like objects, which when mounted and examined with a microscope were seen to be strongly curved rods, taking very nearly the form of a horseshoe, or of oval rings with the lower end cut off. They measured about 640 microns in one direction and 500 across, with the free ends somewhat tapering. Frequently several were attached together in a series, the top of each about 130 microns above the top of the one following. Being much interested in these peculiar structures, I asked Dr. Smith to send me material of other chimæroids, and this he very kindly did. In a young *Hydrolagus colliei* (Bennett), 5 inches long, I found the structures *in situ*. A mucus canal about 2,180 microns below the dorsal denticles was lined with these horseshoe-like structures, placed obliquely a short distance apart, so that each one partly overlapped two others, as seen from above. The free ends project along the margins of the canal, which is widely open above, and the structures obviously serve to keep the canal in shape and open.

In the works of Garman, Dean, Bridge, Jordan, etc., I find no mention of these structures; but they may have been recorded in some work not accessible to me in Colorado.

T. D. A. COCKERELL
UNIVERSITY OF COLORADO

LABELING MICROSCOPIC SLIDES

TO THE EDITOR OF SCIENCE: I was interested in the note published in SCIENCE, by Zea Northrup, in the July 25 issue, on "A New Method for Labeling Microscopic Slides," for I have been following that method for the last five years. I have found it a very successful way in which to obtain a permanent, clear designation for the slides. It is especially valuable in labeling serial sections, for, as soon as the ribbon has been firmly attached to the slides, the glass near the end of the ribbon is easily cleaned and the label then passes through the remaining parts of the process, until finally it is covered with the balsam and cover glass. This gives complete permanency to the writing and only the destruction of the slide will result in the loss of the label. In this connection it may be interesting to some to speak of two features of numbering slides which, though probably not used exclusively by the writer, he has never seen adopted by other workers. In numbering a long series of slides which contain consecutive sections from one imbedded object it is convenient to assign a decimal number to the individual slides. The practise of the writer has been to assign a whole number to the entire embedding of a certain object preceded by the last two figures of the year number; thus if a certain flower bud is the second piece of imbedding which I have done this year the number of that flower bud is 132. Then the first slide cut from that imbedding is 132.1, or the fifteenth slide is 132.15. It may also occur that more than one piece of an object is included under the serial number 132, in which case the slide number for the fifteenth

slide would be 132.1.15 if it is made from the first cutting. This method at a glance tells in what year the imbedding is done and whether or not all of the slides on a given subject are from one piece of material or from several, so that no doubt can exist as to the history of any particular slide. Of course the figure or figures following the first two and preceding the first decimal point identify completely the subject which that slide is connected with. Incidentally this method of numbering saves the instructor's time, in case the slides are for classroom use, and enables him to assign one or more of the slides to definite students with assurance that the correct slides will be returned.

Ernest Shaw Reynolds
Agricultural College, N. D.

Upon the Distribution of Rhodochytrium

During the last three or four years there has been a considerable amount of discussion as to the distribution of *Rhodochytrium spilanthidis* Lagerh. and some remarks have been made suggesting that it was rather curious that it should occur in three widely separated regions and upon three different hosts. The three regions are Ecuador, Kansas and North Carolina. In the North Carolina region upon one of its hosts, *Ambrosia artemisiæfolia* L., it was found covering a considerable area, in fact it extended pretty well from one end of the state to the other. It has since been found to cover a portion of South Carolina extending almost from the mountains to the coast.

The occurrence of the parasite at all points in South Carolina wherever I have made careful search for it has led me to believe that the distribution might be extended to cover most of the southeastern and gulf states and so up the Mississippi Valley and west to Kansas, thus connecting two of these widely separated regions. With this view in mind I wrote to a number of botanists and plant pathologists in the agricultural colleges and experiment stations of the various states covering this territory to ascertain if the parasite occurred in their respective localities. With one exception I received the reply, that so far as they were able to find, it did not occur in any of these localities.

Dr. F. A. Wolf, of Auburn, Ala., sent me specimens collected at Auburn and wrote that he had also found it at Cullman, Ala. The occurrence of the parasite in these two localities makes it very probable that it will be found in the intervening state of Georgia.

Through the kindness of Mr. A. B. Massey I received specimens from Oriole, Md., which is the most northern station for this disease, so far reported, east of the Blue Ridge and Allegheny Mountains. I believe that it may be found still further north if careful search be made for it. It seems to me that there can be no doubt of its being found in Virginia, thus connecting the Maryland and the North Carolina regions.

It is a universal fact that in looking for the parasite I have always found it upon the smooth form of *Ambrosia,* for in both North Carolina and South Carolina there is a smooth and a pubescent form of the host. It also occurs more abundantly where the soil is rather poor and sandy and has not been cultivated for at least one season previous to the occurrence of the parasite.

I also believe that a more continued search for the *Rhodochytrium* will lead to its being found so as to connect at least two of the regions reported, and it is quite possible that it may connect all three of them.

I give with this, localities additional to those already published by Dr. Geo. F. Atkinson[1] where the parasite has been found. The first three are credited to the proper persons reporting them and the rest are those in which I have collected the plant. Oriole, Maryland, Mr. A. B. Massey; Auburn, Alabama, Dr. F. A. Wolf; Cullman, Alabama, Dr. F. A. Wolf; Clemson College, S. C.; Greenville, S. C.; Ridgeland, S. C.; St. George, S. C.; Olar, S. C.; Springfield, S. C.; St. Matthews, S. C.; Yemassee, S. C.; Ninety-six, S. C.; Pendleton, S. C.; Newberry, S. C.; Central, S. C.

John G. Hall
Washington State College

[1] Science, 28, pp. 691–692, November 13, 1908.

SCIENTIFIC BOOKS

The Teaching of Physics. By C. RIBORG MANN. New York, Macmillan, 1912. Pp. xxv + 304. $1.25.

Professor Mann's well-known views on the methods of teaching high-school physics find, in his book on this subject, well-developed and orderly expression, much more thoroughly worked out and carefully arranged than was possible in his numerous earlier papers and addresses. It is only natural that a decided improvement should be the result of such change in form of presentation, and yet it would be difficult to find another development, from fragmentary form into treatise, in which the material has gained so much in value as has the subject matter in review. The volume on "The Teaching of Physics" carries a constructive tone almost from the beginning.

The main lines followed are: The development of the high school itself, from an institution used mainly as a training school for college and university, to one at present so generally appropriated by the people who support it that only a small fraction of all its graduates later enter the university; the influence exercised by college and university upon the curriculum of the high school and upon the form of the separate courses therein; the effect of such influence upon the content and methods of the physics course. This effect seems to the author to be traceable in the change from the natural philosophy of the middle of the past century, with a decided leaning toward discussions of the concrete physical problems of the arts and of every-day life, to the more abstract and disciplinary methods of the later school science. The doctrine of formal discipline receives a share of the blame for the change so traced—a doctrine which has thrown its baneful influence even over the study of the classics of our literature. After citing authorities in the field of educational psychology to prove that the hope of transfer of discipline, gained in one field to another field of mental endeavor, is a mere will-o'-the-wisp, Professor Mann urges the teachers of high-school physics to bring the science home to their pupils, to a state of usefulness such that application may be made naturally and immediately to the needs of every-day life—a thing necessary indeed if a vast majority of the pupils are to receive any appreciable benefit from the subject. He contends that such a change will be accomplished only when the content of the course concerns itself less with highly abstract ideas, less with highly developed systems of units, and more with broad general principles applicable to the real and concrete problems which the pupil, and later the man and the woman, meet in their work and recreation. A discussion of present-day text-books follows—mainly adverse criticism—and some proposed remedies are suggested in the form of new methods of approach to the more fundamental principles. To these criticisms and suggestions is added the further suggestion that only by a process of experimental development will there be evolved a satisfactory high-school course in physics, with equally satisfactory text-books. The need is for cooperative effort and study of the problem on the part of large numbers of physics teachers.

The details by means of which Professor Mann has followed these lines of development have been handled by him generally in excellent and convincing manner, though at times some of them have been thrown into prominence not altogether warranted by their importance. One easily appreciates the criticism of the somewhat dogmatic form in which statements of facts and theories are too frequently made by authors of text-books—such statements are surely enough benumbing to the pupil. The suggestion is good, also, that, so far as possible, the laboratory be used to settle points of uncertainty or of controversy raised in the class room, rather than merely to verify, by measurements, physical laws which are already known by the student far more accurately than his measurements can be made. The author shows, further, that it has been just this attitude, of desire to bridge a gap in knowledge, which has been effective in advancing the science in the past; a student trained to use the laboratory to settle problems, real to him, would be much more likely to find physics of value to him in later years—himself to be of more value to the science.

The use of concrete ideas is treated at some length in one of the chapters; the discussion is given in excellent manner. Careful distinction is made between concepts which are merely specific and such as are concrete. The use of concrete elements in leading up to the formulation of general laws and principles is fully discussed.

Many other points of interest and of real importance to the teacher are considered. For instance, the last chapter of the book is devoted to a valuable discussion of various methods of examination by which the efficiency of the work in the different features of the course may be tested.

There are, however, other points which are not so convincing. The author gives (Chapter V. and subsequent pages—cf. 109–112, 117, 123, 187) a somewhat elaborate development of the ideas that science is the result of demands made by industrial and commercial growth, and that the habits of "cooperative and democratic industry of the Germanic races" (as contrasted with the "innate, immutable ideas" of the "aristocratic Greeks") have been all-powerful in building up our modern physics. Similarly the statement is made and frequently repeated (page 166) that "the man of commerce may think that the world's accounts are settled by money; but the student of real physics . . . knows that energy is the final basis of industrial values." We may agree with these statements, or we may not, as the case may be, but when the author uses them as partial justification for the contention that the energy principle should form the unifying basis of the course in physics to the exclusion of theories and hypotheses, his main arguments for such procedure, valid enough in themselves, lose something of their due force.

Again, in the chapter on the discipline of physics Professor Mann would be more convincing if the statements concerning the transfer of discipline were held within the limits set by the authorities quoted. On page 191 is the statement "since a scientific habit of mind, when developed in physics, is not transferable, while a conscious ideal is transferable . . ."; as a matter of fact the chosen authorities would justify nothing more conclusive in statement than that such habit is "probably not" transferable. The most vigorous opponents, among educational psychologists, of the old dogma of formal discipline would probably hold the question as yet open; this much would be indicated by their recognition of some transfer of discipline, some of them explaining the residual on the theory of common elements, others on the theory of transfer of method.

Occasional references to the principle of relativity and to the principle of least action, induced apparently by the frequent use of Poincaré as authority, are likely to be misleading when found in a discussion of the teaching of high-school physics. These principles are very much in the air in these days, to be sure, but one is hardly justified therefore in stating (page 233) that "this idea of maximum efficiency is valuable as giving a first inkling of the meaning of the principle of least action."

Even though one may feel inclined, on reading the volume, to differ from some statements and may not feel justified in following Professor Mann in constructing a high-school course according to the favorite plan of the author—excluding, as far as possible, consideration of theories and hypotheses—yet there remain reasons in plenty to justify the judgment that this is a notably helpful and searching treatment of a much-harrowed field. Differing or not, as the case may be, on specific suggestions and arguments, the reader finishes the book with admiration for its spirit of helpfulness. The book is more valuable, indeed, because it is ground for some wholesome difference of opinion.

For his basic contention that physics should be made *real* to the students and evidently applicable to their every-day life, and that the students should be trained in this application, Professor Mann should have the praise and support of every serious teacher. The high-school teacher should not be left long in doubt, by college and university officers, as to the acceptability of such physics for college entrance for the relatively few high-school pupils

who later find their way to college or university. No better groundwork could be found for college or technical school physics than the ability, on the part of the student, to apply the science to his every-day problems.

The volume is one of the series which appears under the title "The Teachers Professional Library," edited by Nicholas Murray Butler. The Macmillan Company is to be commended for the attractive and substantial form which the book has been given.

F. E. KESTER

Thick Lens Optics. An elementary treatise for the student and the amateur. By ARTHUR LATHAM BAKER, Ph.D., Manual Training High School, Brooklyn, N. Y. D. Van Nostrand Co. 1912. Pp. ix + 131. $1.50 net.

University texts on optics, as a rule, treat first order lens theory but incompletely and the aberrations of the third and higher order scarcely at all. The average university instructor in physics regards geometrical optics as an alien subject properly disposed of in high school. Reference texts of lens theory, on the other hand, deal largely with the third order theory and fail to give an elementary comprehensive treatment of first order theory.

Baker's little lens primer well fills this gap between the university text and the special treatise and will be heartily welcomed by oculists and by manufacturers and users of spectacles and other low-power lenses. It is confined strictly to first order theory, giving a simple and able treatment of image formation and focal power of combinations of thin and thick lenses. Diagrams are plentiful and good. A great many numerical examples are given and one chapter is devoted to the experimental determination of the optical constants of lens combinations with simple apparatus. When the book is revised it would be well to adopt a less formal style and perhaps either add a chapter on the special problems of spectacle lenses or mould the whole into an introduction to advanced lens theory.

P. G. NUTTING

Prisms. Their Use and Equivalents. By JAMES THORINGTON, A.M., M.D., Ophthalmic Surgeon, Professor of Diseases of the Eye in the Philadelphia Polyclinic. P. Blakiston's Son & Co. 1913. Pp. 144.

This little book is based on its author's course of lectures on this subject delivered each winter at the Philadelphia Polyclinic. It deals with the use of prismatic spectacle glasses in correcting muscular defects of the eye. Methods of evaluating prisms combined with spherical and cylindrical lenses are described and a number of useful tables given. The diagnosis and measurement of imperfect muscular balance (*heterophoria*) and of deviation from parallelism (*heterotropia*) of the eyes are discussed at some length. The book is well written and well illustrated and bears evidence on every page of the author's grasp and first-hand knowledge of the subject.

P. G. NUTTING

SPECIAL ARTICLES

A PARASITE OF THE CHINCH BUG EGG

IN the experiments conducted this year to determine the time of the first appearance of young chinch bugs and the mortality of the eggs, a large number of eggs were collected in the field for examination. The eggs which were collected at different intervals and in different localities were examined daily. While thus examining the eggs it was noticed that some of them became dark in color instead of assuming the usual red coloring. These eggs were isolated and on May 19 there emerged from them three parasites. With these three parasites as a basis, the life history was carried through four generations, running up to July 5. Since this was the time between the two broods of the chinch bugs, it became impossible to obtain additional chinch bug eggs with which to continue the work. From July 5 to July 23 only an occasional parasitized egg was found in the field, but beginning with the latter date, parasitized eggs were found in large numbers in the corn fields and the second generation was obtained by August 10. Up to the present date

this year over 325 individual parasites have been bred out. The length of the life cycle has been found to vary from ten to eighteen days, depending on the climatic conditions.

The parasite has been found in every wheat and corn field examined around Manhattan. Of 3,101 eggs collected between April 28 and June 10, the average per cent. of parasitism was 20.8, and of 116 eggs collected at Crawford (central Kansas) the per cent. of parasitism was 16.3. The insect has also been taken at Dodge City (southwestern Kansas).

The work is still under way and a full description of the parasite together with notes on its life history and efficiency will be published later.

Mr. A. B. Gahan, entomological assistant of the Bureau of Entomology, U. S. Dept. of Agric., to whom specimens of the parasite were sent for determination, says:

> I have made a partial examination of these parasites and find them to belong to the family *Proctotrypidæ*, and they probably fall close to the genus *Telenomus*. It will require further study for me to determine definitely regarding them. It seems probable that they represent not only a new species, but possibly a new genus.

In a more recent letter Mr. Gahan writes:

> After exhausting every effort to determine the parasites of the chinch bug which you sent me and failing to find any such species described, I turned the specimens over to Mr. J. C. Crawford, of the United States National Museum, to see what he could do with them. He informed me yesterday that he had arrived at the same conclusion as myself, namely, that the species would require a new genus.

James W. McColloch
Kansas State Agricultural College
and Experiment Station

Some Observations on the Sexuality of Spirogyra

The gametes of *Spirogyra* are described in the text-books of botany as being morphologically alike. A few workers have claimed that the female gametes in certain species are larger than the male. Aside from these observations the writer knows of no published accounts of attempts to point out other differences between the male and female gametes of *Spirogyra*. A large number of measurements of the conjugating cells have been made by the writer, but no constant difference in their size has been found. Several examples were observed where the transverse diameter of the filaments producing male gametes was slightly less than that of those in which the females were formed. The male cells may be longer or shorter than or equal the length of the females. The cells of any one filament vary in length. It is, therefore, quite evident that the gametes of some *Spirogyras* can not be distinguished as male and female on the basis of their relative size.

The writer observed a few years ago that the chloroplasts of the female gametes of *Spirogyra crassa*, just after the formation of the conjugating tubes, contained a much larger amount of starch and more pyrenoids than those of the male. The pyrenoids of the male gametes were larger and the amount of starch surrounding each pyrenoid was considerably less than in the females. Practically the same kind of differences seen in the gametes of *Spirogyra crassa* were observed in three other undetermined species of *Spirogyra*. By careful fixation of material of these unidentified species, taken just before or immediately after conjugation had begun and staining in iron-hemotoxylin and erythrosin, the cytoplasm of the majority of the female gametes stained a little more darkly than that of the males. The density of the staining of the female gametes was so marked in some filaments that they could easily be distinguished from the male even when the two were not in close proximity. No examples of conjugating cells were found where the male gamete stained more darkly or in which there were more starch and pyrenoids than in the female. Every year during the past seven years, the writer has examined several hundred filaments of *Spirogyra* in which conjugation was occurring or had just taken place, and in every example, the gamete with less starch and pyrenoids was passing over to or had just united with the gamete possessing a greater amount of starch and pyrenoids. The protoplasts of any one filament

are to all appearances vegetatively alike. They differ apparently only in size. Zygotes were never found in both filaments, but only in the one containing the larger amount of food.

The difference in the number and size of the pyrenoids and the amount of starch present in the chloroplasts and in the staining reaction of the cytoplasm of the gametes, clearly indicate at least that in certain species of *Spirogyra* the male and female gametes are distinctly morphologically as well as physiologically different. Since starch is formed more abundantly in the female gametes than in the male, the female plants evidently possess a greater vegetative activity than the male plants. Blakeslee[1] in his recent studies of *Mucors* concludes that the female plants (+ strains) in diœcious forms are more vegetatively luxuriant than the male plants (— strains).

A more detailed account than is presented here will appear later.

HARLAN H. YORK

DEPARTMENT OF BOTANY,
BROWN UNIVERSITY

THE SOCIETY OF AMERICAN BACTERIOLOGISTS

SYSTEMATIC AND PHYSIOLOGIC BACTERIOLOGY

THE annual meeting of the society was held in New York City, December 31, 1912, and January 1 and 2, 1913, under the presidency of Dr. William H. Park. The sessions were held at the American Museum of Natural History, the University and Bellevue Hospital Medical College and the Rockefeller Institute. The society expressed its indebtedness to these institutions for their courtesy. The annual dinner was held on Wednesday evening, January 1, 1913, at which the president's address was delivered. Dr. Park spoke upon "The Applications of Bacteriology in the Activities of a City."

With this as his text Dr. Park traced the history of the Research Laboratories of the Board of Health of New York City, an institution which easily takes rank with the Pasteur Institute of Paris and other institutions of the kind in Europe. In the original work which has been done under Dr. Park's direction no other American laboratory engaged in public health work can point to so many achievements which have resulted in advancing our knowledge of infectious diseases and methods for controlling them.

The following officers were elected for a term of one year:

President—C.-E. A. Winslow.

Vice-president—Charles E. Marshall.

Secretary-treasurer—A. Parker Hitchens.

Council—W. J. MacNeal, L. F. Rettger, D. H. Bergey, H. A. Harding.

Delegate to Council of A. A. A. S.—S. E. Prescott.

The following papers were read:

The Value of Glycerinated Potato as a Culture Medium: M. R. SMIRNOW, M.D., New Haven, Conn., instructor in bacteriology and pathology, Yale Medical School.

The glycerinated potato culture medium belongs to the class of the so-called media, which as the term implies, are media of various compositions and are used only for special purposes. They may be employed as follows: (1) for the purpose of isolating microorganisms; (2) to furnish a sufficiently favorable medium for the growth of certain organisms; (3) for specific or differentiating tests; (4) to bring out special features of growth. Aside from blood media, the most frequently used of the special media are the glycerinated potato and agar, but even these are practically limited to the cultivation and the study of acid fasts. It has long been the opinion of the writer that if some of our so-called special media were put to a more general use, hitherto unknown biological features in the study of microorganisms would come to light. This was emphasized by the finding of a marked contrasting culture on glycerinated potato of a glanders bacillus, which was being isolated at our laboratories during the last year. This organism was isolated from a human case of glanders. When first obtained it gave but a faint yellow growth on plain potato, by no means the so-called honey-like growth. It was then planted on glycerine potato with more success. On this medium it gave a luxuriant growth of a bright yellow color and typically honey-like in character. It was this peculiar and striking difference in the growth of the glanders bacillus that led up to the work here outlined. The cultural characters of twenty-five microorganisms were studied on glycerine potato, plain potato and broth potato, the

[1] Blakeslee, A. F., "A Possible Means of Identifying the Sex of (+) and (—) Races in the *Mucors*," SCIENCE, N. S., 37: 880–881, 1913.

two latter media being used as controls. The media were freshly made as needed. A number of potatoes were cut into cylinders, washed in running water for about an hour and then allowed to remain in a basin of water over night. One third of the lot was placed into 6 per cent. glycerine broth, and one third into plain broth for about two hours, and the remainder was left in the water. The three batches of potatoes were then tubed and glycerine broth and plain broth were poured into the tubes up to the level of the glycerinated and broth potato, respectively. The plain potato had no fluid added to it. The media were then sterilized in the autoclave at 18 lbs. pressure for 15 minutes, and then stored until used in cold place to prevent drying. The plants were all made of the same stock cultures, at the same time incubated both at 22° and 37.5° C. Each test was carried out a number of times, to assure constant results. The results obtained will for convenience be divided into three groups. The first comprising bacteria that show a striking contrast in their cultures on the different potato media; the second showing a slight difference, and the third those showing no difference. The first group includes the following microorganisms:

Two different strains of *B. mallei* of human source.
One strain of *B. mallei* received from New York.
Two strains of *Actinomyces* received from Washington.
B. pyocyaneus, old stock culture.
B. subtilis, old stock culture.
An unidentified spore-forming bacillus, isolated from the intestinal tract of a rabbit and designated as "B. rabbit spore."

To sum up this group: The three strains of the glanders bacillus give lighter colored, moister and more typical honey-like growths on glycerine potato. Their growth on plain potato is more brownish yellow in color and the potato is usually discolored. A metallic luster was noted on broth potato on several occasions with each strain. The *Actinomycetes* give a dry culture made up of isolated colonies, raised and of decided brown color on plain potato, whereas on glycerinated potato they give rise to a luxuriant growth of more conglomerated colonies of a honeycomb-like arrangement and of a light-yellow color. The *B. pyocyaneus* gives a brighter and deeper green pigment on the glycerine medium and a brown or green-brown slimy growth on ordinary potato. The *B. prodigiosus* gives a bright cherry-colored growth on glycerine potato and agar, at 22° C., a slight red or orange on broth potato and a faint pink on ordinary potato. It gives hardly any color at 37.5° C., on any of the media. The *B. subtilis* apparently grows better on ordinary potato, producing a heavy furred culture of brown color. On the glycerine potato it gives a rather delicate lightly furred growth of a light-yellow color. In the second group are included:

B. coli, stock culture.
B. mucosus, stock culture.
Sp. cholera, stock culture.
An unidentified organism isolated from rabbit feces, here designated as "B. rabbit feces."
An unidentified pleomorphic bacillus isolated from a contaminated plate.
A mould.

In general it may be stated that these organisms do not show striking differences in their growths upon the three varieties of potato. Glycerinated potato permits as a rule a much lighter colored growth, less raised, and often more homogeneous in character. In the third group are included the diphtheria, typhoid, dysentery and grass bacillus, the *Streptococcus pyogenes, Staphylococcus aureus* (two strains), *Sarcina aurantia* and a yeast. There are no visible differences in the cultural characters of each of these organisms on the potato media under consideration. The chromogenic organisms (*Sarcina aureus*, yeast) seemed to give brighter and more intense pigment production and at times somewhat more luxuriant growths on the glycerinated potato. In conclusion the writer desires to bring to your attention that with the particular strains used glycerinated potato affords a more favorable medium for most of the twenty-five microorganisms tested. It allows more moist, more homogeneous, less raised growth characteristics, of lighter or brighter color. With the *B. prodigiosus* the color was greatly intensified. Glycerine potato is seldom discolored, whereas both broth and plain potato are frequently discolored, particularly the latter. From the above we may conclude that a more general use of glycerinated potato suggests itself.

The Preservation of Stock Cultures: A. Parker Hitchens, Glenolden, Pa.

For the preparation of stock bacterial vaccines it is necessary to have constantly on hand a large number of cultures of the various pathogenic bacteria. For the preparation of vaccines for the treatment of the various regional mixed infections, it is deemed necessary to collect the various species and types in each region. To keep fresh stock of any culture frequent transplantation is necessary. As the intervals between transplants vary

considerably with the different cultures, a card-catalogue system has been devised. Under this system each culture is represented by a card, upon which are recorded all the dates of transplantation as the fresh cultures are made. The cards are kept in a file, with each card placed under the date at which the next transplant of its culture is necessary. The work upon the cultures each day is carried out in accordance with the cards filed under that date. During the intervals between transplants, all cultures except the *B. influenzæ*, gonococcus and meningococcus are kept cold. Five dates of each culture are kept and the tube of most recent date is unopened. In order to keep a large number of cultures constantly on ice, we have had a refrigerator constructed especially for this purpose. The refrigerator, well insulated, is about seven feet long, six feet high and two feet in depth. It is divided into six large compartments, three above and three below. The middle compartment of the upper row contains the ice, and it is always filled to its capacity, 500 pounds. This quantity of ice maintains a temperature of 10° to 15° C. throughout the entire refrigerator. The refrigerator is well drained and the open framework of the interior allows free circulation of air. Five compartments are devoted to the cultures. These compartments are provided with drawers, which slide in grooves and are easily removed. Each drawer is of such dimensions that two crates of cultures fit end to end within it. The total number of drawers is 63 and the total capacity 1,600 cultures. The front of each drawer is provided with a groove into which a card is fitted designating the contents of the drawer. With this refrigerator and our system of transplanting we are able to keep ready for immediate use a fresh supply of all the cultures necessary for the preparation of bacterial vaccines.

A Refinement of the Technic of Quantitative Bacteriological Analyses: W. D. FROST, Boston, Mass.

It is generally recognized that the measured quantities of water, used for dilution, lose in volume during sterilization and upon standing. The exact amount of this loss or the means of preventing it are apparently not generally understood. In an extended series of experiments it is found that the loss varies from 1 to 8.8 per cent. and that the average is 5.07 per cent. Various types of autoclaves are tested and it is found that there is considerable variation in the different types. The loss is evidently due to the ebullition and escape of steam, especially during cooling. This loss can be prevented by closing up the autoclave cold, as is frequently done in sterilizing blood serum. When closed in this way the autoclave is not always efficient in the time or at the pressure ordinarily used. In order to insure sterilization it will be necessary to extend the time, increase the pressure or sterilize on two consecutive days. The evaporation due to standing a few weeks is equal to the loss in the autoclave. This is not prevented by a thin paper cap. Paraffined paper is recommended, also cork stoppers covered by a thin layer of cotton instead of an ordinary cotton plug. In using the bottles after making the dilution it is suggested that the sterile side of this cap be forced into the mouth of the bottle with the cork. This permits efficient shaking.

The Significance of the Time at which Gas is produced in Lactose Peptone Bile: WILLIAM W. BROWNE, Ph.D., College of the City of New York.

During the summer of 1912 routine bacteriological examinations of oysters of Narragansett Bay were made under the direction of Professor F. P. Gorham, of Brown University, with the hope of determining the extent of the pollution of the oyster beds of Rhode Island by the sewage of the neighboring cities and towns. The examinations were made according to the methods proposed by the American Health Association. Lactose peptone bile was used as a presumptive test to indicate the presence of members of the *Bacillus coli* group and other lactose fermenters of intestinal origin. (1) Lactose peptone bile tubes inoculated with the shell liquor of oysters taken from 119 different beds produce the greater part of their gas by the end of the forty-eighth hour. (2) Lactose peptone bile tubes inoculated with the shell liquor of oysters taken from polluted areas produce almost all their gas by the end of the forty-eighth hour. (3) Lactose peptone bile tubes inoculated with the shell liquor of oysters taken from districts comparatively free from pollution produce the greater part of their gas by the end of the seventy-second hour. (4) Consideration of this temporal factor in the production of gas in lactose peptone bile might aid in the determination of whether the pollution was recent or remote.

A Comparative Study of the Smith Fermentation Tube and the Inverted Vial for the Determination of Sugar Fermentation: WILLIAM W. BROWNE, Ph.D.

During the sanitary survey of Narragansett Bay conducted under the direction of Professor F. P. Gorham, of Brown University, a comparison was made of the efficiency of the Smith fermentation tube and the inverted vial as used in the presumptive test with lactose peptone bile to indicate the presence of members of the *Bacillus coli* group and other lactose fermenters of intestinal origin. Fermentation tubes and inverted vials containing lactose peptone bile were inoculated with the shell liquor of oysters taken from polluted areas and the following results were obtained:

Percentage of Efficiency

	Cubic Centimeter 24 hrs.	48 hrs.
Fermentation tube	84.6%	94.3%
Inverted vial	92.3%	96.1%
	One Tenth Cubic Centimeter	
	24 hrs.	48 hrs.
Fermentation tube	86.5%	90.3%
Inverted vial	59.5%	84.6%
	One Hundredth Cubic Centimeter	
	24 hrs.	48 hrs.
Fermentation tube	32.6%	55.7%
Inverted vial	23.0%	42.3%

Resistance of Microorganisms Suspended in Glycerine or Oil to the Sterilizing Action of Heat: C. J. Bartlett and F. B. Kinne.

Dreyer and Walker have recently reported the results of heating spores suspended in glycerine and oil. They show that spores in glycerine were not killed with certainty after heating two hours at 1½ atmospheres, 2 hours at 1¼ atmospheres or one half hour at 2 atmospheres. In our experiments we have worked with the *Staphylococcus aureus,* with the *Bacillus anthracis* and with the *Bacillus subtilis,* and with a bacillus with very resistant spores, apparently the *Bacillus vitalis.* These have been heated in glycerine, water, olive oil, cottonseed oil and paraffin for different periods at the temperature of boiling water and in the autoclave at 7½ lbs. pressure and at 15 lbs. pressure. The *Staphylococcus aureus* is quickly killed in all of these, even at the temperature of boiling water. The spores of the anthrax bacillus and of *B. subtilis* are quickly killed in boiling water, usually in three minutes or less. In glycerine they have been found alive after one and one fourth hour at this temperature and in oil after fifty minutes, and in the autoclave after heating in oil fifteen minutes and in glycerine in ten minutes at 7½ lbs. In water they do not live after five minutes at this pressure. The spores of the *B. vitalis* are killed in about one half of these tests by heating in boiling water for two hours, while in oil and glycerine they resisted this temperature for two hours in every instance. After heating in the autoclave they were found alive in oil at 15 lbs. for two hours and in glycerine after one and a half hour, but not longer. In water they were never found after twenty minutes at 7½ lbs. and after ten minutes at 15 lbs. It is evident that spores are more resistant to the action of hot oil and glycerine than to that of hot water.

The Comparative Viability of Pneumococci on Solid and on Fluid Culture Media: L. J. Gillespie, Hospital of the Rockefeller Institute for Medical Research.

The following facts have been observed: (1) Broth which is perfectly suited for the growth of copious cultures of the pneumococcus often requires many more organisms (frequently a million times as many) to initiate growth than does agar. (2) Cultures which when fresh from the animal body show a marked effect become on cultivation upon artificial media indifferent in their requirements. (3) Certain cultures (of any strain) show no effect even when fresh from the body. (4) Differences in chemical composition of broth and of agar play little or no part because an imitation "solid" medium, prepared from filter paper and broth, serves nearly as well as agar. (5) The possibility that insufficient aeration in the case of broth plays any rôle is ruled out by comparing agar plates with agar shake cultures. These phenomena may be explained if we suppose that the pneumococcus sometimes requires for its multiplication that substances from the animal body be present in the immediate environment of the cocci, the concentration of which can be too far reduced in the case of broth by diffusion aided by convection. If we suppose rather that the necessary substances are produced by the pneumococci themselves we may assume that such substances are always necessary, and that during acclimatization to artificial media the capacity for such metabolism is increased.

Studies of the Subtilis Group: Karl F. Kellerman and Edna H. Fawcett, Bureau of Plant Industry, Washington, D. C.

The *Subtilis* group includes the spore-forming aerobic and facultative anaerobic bacteria which liquefy gelatine. Numerous cultures of members of this group have been obtained from various sources. Biometrical study of their acid produc-

tion, ammonia production, and the reduction of nitrates, together with careful comparison of their morphology, has shown the necessity for allowing greater range in the description of *Bacillus subtilis, B. cereus, B. mycoides* and *B. megatherium.* No decision has as yet been reached regarding the validity of *B. asterosporus* or *B. ruminatus.* For the first four species named the following synonymy is submitted:

B. subtilis

B. subtilis Cohn (Emend) 1876, (Flugge) 1886, (Zopf) 1883.
mesentericus vulgatus Flugge, 1886.
mesentericus fuscus Flugge, 1886.
liodermus Flugge, 1886.
aerophilus Flugge, 1886.
lævis Frankland, 1887.
mesentericus fuscus Trevisan, 1889.
mucosus Zimmermann, 1894.
destructans Wright, 1895.
mesentericus ruber Globig (Flugge), 1896.
leptosporus Klein, 1900.
sessilis Klein, 1900.
pumilis Gottheil, 1901.
simplex Gottheil, 1901.
mesentericus Chester, 1903.
malariæ Klebs. (Original not consulted.)

B. cereus

B. cereus Frankland, 1887.
ulna Cohn, 1875. (Incomplete description.)
ramosus liquefaciens Flugge, 1886.
subtilis Frankland, 1887.
subtilis Sternberg, 1890.
subtilis Eisenberg, 1891.
petroselina Burchard, 1892.
cursor Burchard, 1892.
loxosus Burchard, 1892.
goniosporus Burchard, 1892.
turgescens Burchard, 1892.
limosus Russel, 1894.
capillaceus Wright, 1895.
crinitum Wright, 1895.
subtilis Wright, 1895.
subtilis Lehman and Neumann, 1896.
ellenbachensis Stutzer and Hartleb, 1898.
fusiformis Gottheil, 1901.
stoloniferus Pohl, 1903.
lutulentus Kern. (Original not consulted.)

B. mycoides

B. mycoides Flugge, 1886.
figurans Crookshank, 1886.
bassicæ Pommer, 1886.
bacterium casei Adametz, 1889.
ramosus Frankland, 1889.
radicosus Eisenberg, 1891.
implexus Zimmermann, 1890.
intricatus Russel, 1892.

B. megatherium

B. megatherium De Bary, 1884.
tumescens Zopf, 1885.
lacteus Lembke, 1897.
petasites Gottheil, 1901.
graveolens Gottheil, 1901.
granulosus Russel, 1892.

Parasites found on Rats in Providence: GEORGE H. ROBINSON, Brown University.

The examination of the rats of Providence for evidence of plague and for the occurrence of parasites has extended over a period of six months, from July to December. During this time 342 rats from different parts of the city were inspected. No evidence of plague was found. The specimens were evenly divided as to sex. As to species there were 333 specimens of *Mus norvegicus,* 2 of *Mus alexandrinus,* 1 of *Mus rattus,* 4 which showed evidences of being a cross between *Mus norvegicus* and *Mus alexandrinus,* 1 apparently a cross between *Mus norvegicus* and *Mus rattus,* and 1 *Mus musculus.* Of these 342 rats, 57 per cent. were infected with fleas, 21 per cent. with mites (*Lælaps echidninus*) and 24 per cent. with lice (*Polyplax spinulosus*). 2,053 fleas were found, consisting of 75 per cent. *Xenopsylla cheopis* Rothschild, 22 per cent. *Ceratophyllus fasciatus* Bosc, 2.5 per cent. *Ctenopsylla musculi* Duges and 0.5 per cent. *Ctenocephalus canis* Curtis. No evidence of a regional distribution of the fleas was observed. A marked seasonal variation was noted, the average flea per rat for July–September being 10.2, while that for October–December was 3.7. The largest number of fleas taken from a single specimen was 300. No relation was found between a filthy habitat and the number of fleas, for the average flea per rat was higher, in general, for the rats from dwelling houses and restaurants than for those from stables and docks. 12 per cent. of the specimens were affected with sores. Parasites, the encysted form of the cat tapeworm, *Tænia crassicollis,* and the ova of some undetermined form were found in the liver of 7 per cent. of the rats. This condition occurred most frequently in the rats obtained from markets.

Comparison of Two Methods for Bacterial Analysis of Air: G. L. RUEHLE and H. A. HARDING.

Report of progress in the comparison of the Rettger method with the official sand filtration method. An exact comparison was found to be difficult to obtain and the relative value hard to estimate. Study to be continued.

A Biometric Study of the Streptococci from Milk and from the Human Throat: E. C. STOWELL, C. M. HILLARD, M. J. SCHLESINGER.

Two hundred and forty pure strains of strepto-

cocci isolated from milk and from the human throat have been compared as to their morphology, Gram stain and gentian violet reaction by the plate method, and their quantitative acid production in seven carbohydrates and related organic media. Hemolysis was studied with 92 strains. We have been able to make no correlation between the length of chain and the relation to violet stain with any other character. Seventeen out of 92 cultures gave hemolysis when streaked on blood agar plates. Five of these cultures came from normal milk, five—the most vigorous hemolizers—were from milk where udder trouble was indicated in the cow, and seven were normal throat forms. The seven substances tested showed a definite order of availability for the acid production. This order ("metabolic gradient") and the per cent. of culture yielding 1.2 per cent. or more of acid when grown at 37° C. for three days is shown in the following table:

	Per Cent.
Glucose (monosaccharide)	98.0
Lactose (disaccharide)	76.0
Saccharose (disaccharide)	65.5
Salicin (glucoside)	42.7
Raffinose (trisaccharide)	37.5
Inulin (starch)	9.0
Mannite (hexahydria alcohol)	1.5

It will be noted that the degree of availability is closely associated with the size and complexity of the substance. According to the positive reaction —over 1.2 per cent. acid—in the test substances 88 per cent. of the cultures may be placed in eight groups. The following features separate milk from throat streptococci: (1) milk organisms yield over 2.5 per cent. acid in lactose and saccharose at 37° C.; (2) they seldom ferment substances higher in the metabolic series than saccharose; (3) they readily ferment dextrose, lactose and saccharose at 20° C. On the other hand, throat streptococci (1) seldom yield over 2.5 per cent. acid in any substance; (2) over 40 per cent. of the cultures yield over 1.2 per cent. acid in either salicin or raffinose; (3) at 20° C. they almost never attack any of the seven test substances.

A Systematic Study of the Coccacæ in the American Museum of Natural History Collection: I. J. Kligler, Department of Public Health, American Museum of Natural History.

A biometric study of 54 strains of cocci in the museum collection was made in order to test the classification proposed by the Winslows in their book on the "Systematic Relationship of the Coccaceæ." Twelve morphological and physiological tests were applied and the results recorded quantitatively whenever possible. The results corroborate the work done by the Winslows. The cocci—other than streptococci—group themselves into five distinct classes according to the pigment produced as follows: (*a*) *White pigment—Albococcus;* (*b*) *orange pigment—Aurococcus;* (*c*) *yellow pigment—Micrococcus;* (*d*) *yellow pigment and packets—Sarcina;* (*e*) *red pigment—Rhodococcus.* The other properties correlate remarkably with that of pigment production and prove that this generic division is a fundamental one. The definition of species is also based on real differences. The species recognized by Winslow were found to be valid, but the number was incomplete. Three new species were recognized (*Alb. urea, M. melitensis* and *S. aurantiaca*) and the possible existence of a few others suggested. Further study is necessary. The application of the principles of biometry to the systematic study of the Coccacæ has yielded very successful results. It is hoped that new workers will apply this principle to the systematic study of this and other groups of bacteria.

Bacteriological Collection and Bureau for the Distribution of Bacterial Cultures at the American Museum of Natural History, New York: C.-E. A. Winslow.

In January, 1911, a prospectus, from which the following sentences are quoted, was sent out from the American Museum to the leading laboratories of the country. "The Department of Public Health at the American Museum of Natural History has equipped a laboratory to serve as a central bureau for the preservation and distribution of bacterial cultures of both pathogenic and non-pathogenic organisms, and particularly of types of new forms and varieties. It is hoped that the laboratories of medical schools, colleges, boards of health, agricultural experiment stations, etc., and those engaged in biochemical work of all sorts, will furnish the museum with cultures at present in their possession, and the laboratory is now ready to receive and care for any such cultures. Types of new species and varieties are particularly desired at the present time and as they may be isolated in the future. The laboratory, of course, can not undertake to keep on hand bacteria difficult of cultivation, such as can be maintained only for a few weeks after isolation from the body; neither can it at present supply virulent cultures which rapidly lose their virulence under laboratory conditions. It should, however, be able to furnish

cultures of organisms of all the ordinary types which can be maintained under cultivation. Pathogenic forms will be sent only to properly qualified persons.'' The value of the proposed collection was quickly appreciated. Cultures from all over the United States and Canada have been contributed freely. In all, 45 different laboratories have sent in cultures, and arrangements have been made for exchange with Professor Kraus, of Vienna, who now has charge of the famous Kral collection. On December 1, 1912, the collection included 578 strains representing 374 different named types, and in the list, which has been printed and may be obtained on application, are most of the important pathogenic and non-pathogenic species which have been definitely described.

During the period of somewhat less than two years, from January 1, 1911, to December 1, 1912, the laboratory distributed to 122 different colleges and research laboratories of the United States and Canada 1,700 different cultures, in every case without charge. It is the policy of the department to send cultures free to all teaching laboratories of college and university grade, and to all research laboratories, whether cultures are sent to us in return or not. Many cultures have been called for by teaching laboratories for use in their class work. The most important service the laboratory has been able to render, however, has been in furnishing authentic cultures to investigators who have been making a study of certain special groups, and the published papers which have resulted, in which various detailed characters of the museum types are described, of course greatly increase the value of the collection.

DAIRY BACTERIOLOGY

Transportation of Milk: M. C. SCHROEDER, M.D., assistant director, Research Laboratory, Department of Health, City of New York.

The problem of the transportation of milk is influenced chiefly by the necessity of subjecting it to the long or the short haul. Most of the smaller cities and towns receive milk from a distance of ten miles, so that milk is transported in wagons only and is delivered to the customer quite fresh. Here, icing during the warm, and protection during the cold, together with frequent inspection of the delivery wagons, and the taking of samples for bacterial tests solve the problem fairly well. New York receives about 30,000 quarts a day from about 145 such outlying farms. The greater bulk of the milk, about 1,800,000 quarts, is brought from distances of 50 to 300 miles. This milk is first drawn to the receiving station, mixed in tanks, simply aerated, or pasteurized and cooled, bottled and canned, and shipped in refrigerator cars holding 272 to 375 40-quart cans, or from 450 to 700 boxes of 12 quarts each. The most important question in the long haul is the refrigeration. Two methods of icing have been utilized. Direct (crushed ice being placed upon cans and bottles), second ''indirect'' (the ice being placed in boxes called bunkers at the end of the car). The bunkers are found to be too small for the ice necessary to keep the milk cold if the weather is hot or the journey long. Milk comes over 15 railroads and enters New York through eight terminals. Trains start in the country from 7 A.M. on, and arrive at the terminal from 9 P.M. to 2 A.M. if not delayed. At the terminal it is loaded in large trucks and is drawn one or more miles to pasteurizing or distributing centers. Here it is handled and sorted and finally loaded into smaller wagons for delivery. The milk supply of New York is safeguarded from bacterial contamination as follows: by annual sanitary inspection of the farms on which the milk is produced, and the more frequent reports of the farmers delivering the milk as to the conditions existing of production and care, by inspecting the icing of the milk and the conditions of the cans and bottles being shipped back to the creamery; by inspecting the conditions under which it is sold; it also seeks to detect the condition of production, transportation and sale by taking bacteriological samples of milk from creameries, at the railroad terminals, from wagons, pasteurizing plants, hospitals, stores, etc. Thus last year the number of samples taken and analyzed was 61,142. For the control of the milk supply, the Department of Health has only 24 inspectors for about 44,000 farms, 30 inspectors for the five boroughs and 4 inspectors taking bacteriological samples for both city and country.

Problems in Sanitary Milk Classification, with special reference to the Experience in New York City: ERNST J. LEDERLE, Ph.D., Commissioner of Health, City of New York.

In contradistinction to most other large municipalities, New York City undertakes practically the entire supervision of its milk supply from the cow to the consumer, notwithstanding that nearly all the 45,000 farms on which this milk supply is produced are located outside the city, and more than 6,000 of them outside the state. The milk

supply may become a source of danger to the public health by being infected with the germ of bovine tuberculosis, the germs of typhoid fever, scarlet fever, diphtheria and tonsillitis, by having in general an excessive bacterial growth and by not having a proper nutritive value. In view of these sources of danger, the means to be employed to make public milk supplies safe are as follows: (1) the prevention of adulteration; (2) the production of a clean milk of low bacterial count. This involves cleanliness of the cows and milkers, clean barns, clean vessels, the exclusion of dust, immediate reduction of temperature after milking, icing during transportation, the sale in sanitary stores; (3) the production of milk free from pathogenic organisms, involving the prevention of the introduction of infectious disease through human agencies, flies and dust. The general milk supply of every large city is unfit for use in infant feeding, and as the attempt to bring the general market milk to the degree of purity required for infant feeding can never be successful, the only way in which sanitary authorities can meet existing conditions is by requiring the pasteurization of all milk which is not of special grades. The official classification of milk in New York City is as follows:

Grade A:
1. Certified.
   Guaranteed.
2. Inspected milk (raw).
3. Selected milk (pasteurized).

Grade B:
1. Selected milk (raw).
2. Pasteurized milk.

Grade C:
   For cooking.

The following changes are under consideration: (1) the elimination of Grade *B* (raw) entirely, and requiring it to be pasteurized; (2) the elimination entirely of Grade *C* from the retail trade; (3) an increase in the requirements for milk intended for pasteurization.

Problems in Sanitary Dairy Inspection: H. A. Harding.

Milk resembles the human race in that its value is determined by two forces, its inheritance and its environment. Inheritance fixes the amount of solids which is normal to the milk. The other elements of its food value are determined by the environment under which it is produced and handled. The problem in sanitary dairy inspection is to provide an inspection which affects the selling price of the milk. This can probably be best accomplished by establishing market grades of milk and by defining these grades in terms of the conditions surrounding the production and transportation of the milk. The value of this financial element in sanitary milk inspection is well illustrated by the Geneva milk supply. In October, 1907, all of the milk coming to this city was graded on the basis of the conditions under which it was produced. It was found that the conditions of the production of 37.5 per cent. were poor, 57.5 per cent. were medium and 5 per cent. were good. The conditions then changed so that the producers were paid on a sliding scale, making it more profitable to produce the better grades of milk. In March, 1911, the milk supply of the city graded on the same basis as above was 87.5 per cent. good and 12.8 per cent. excellent. Conditions again changed so that there was no longer this direct connection between the conditions surrounding production and the price received, and in October, 1912, the city supply on the same basis as the above was 81.5 per cent. medium, 15.7 per cent. good and 2.6 per cent. excellent. Farmers have a better financial sense than is generally supposed and sanitary milk will not be produced on a large scale until its production becomes financially more profitable than that of the dirtier grades. Details are given in *Bulletin of New York Agricultural Experiment Station.*

Notes on Yeast-like Organisms in Whey: S. F. Edwards, Bacteriological Laboratory, Ontario Agricultural College.

During the summer of 1909 some work was begun on the problem of so-called fruity flavor or sweet flavor in cheese in western Ontario. The trouble was supposedly due to yeasts or yeast-like organisms. Samples of whey were secured from twenty-five factories where this flavor was prevalent, and from these samples twelve varieties of yeast-like organisms were isolated. Some of the yeasts (so-called) were found in the whey from more than one factory, and some factories had several varieties in the whey. Three lots of experimental cheese were made up, using a starter of these organisms, and the flavors typical of different factories were produced, whereas no off-flavor was present in normal control cheese. These organisms have been retained in the laboratory and further study has been made as the time permitted. The term yeast is a misnomer, for with but one exception we have been unable to demonstrate spore production. Very little attention has been given to morphology, sole dependence for dif-

ferentiating the varieties having been placed on cultural and biological characters. A summary of these characters is given in the subjoined table.

The Cultural Characters of Whey Yeasts

+ indicates positive results. Blanks indicate no action.
For convenience the organisms are designated by letters.

	Ferments[1]				Produces Acid in						Reducing Sugars from				Peptonizes Milk	Liquefies Wort Gel[2]	Indol in Dunham, 20 Days	Indol in Uschinsky + Peptone	Ammonia in Nitrate Broth	Alkali in Litmus Milk
	Dextrose	Saccharose	Lactose	Maltose	Dextrose	Saccharose	Lactose	Maltose	Raffinose	Mannite	Saccharose	Raffinose	Starch	No Reduction in Mannite						
*A*2					+								+		+	+		+		
*A*5	+		+			+	+				+	+			+	+	+	+		
*B*2	+	+			+	+			+		+	+			+	+	+	+	+	+
*B*4	+	+			+	+			+	+	+	+			+	+	+	+	+	
*D*1															+		+	+	+	+
*J*1	+	+	+		+	+	+					+				+	+	+	+	
*J*2	+					+		+			+				+	+	+	+	+	+
*K*1	+	+		+		+		+	+			+			+	+		+	+	
*K*3	+	+			+	+	+				+	+						+		+
*O*1	+				+		+		+		+	+				+		+		+
*P*1	+	+	+		+	+	+					+			+	+		+		
*X*2											+	+				+			+	
Control																				

All of the organisms made scanty growth in Cohn. Yeasts *D*1, *J*2, *P*1, *X*2 made scanty growth in Uschinsky; the others none. Organisms *A*2, *J*1, *P*1 produced a marked pineapple flavor in wort agar plates, and *A*5 and *J*2, marked strawberry flavor in the same medium. Further work with these organisms is planned.

The Action of Bacillus Bulgaricus in Suppressing Gassy Fermentations in Cheese-making: C. F. DOANE, Dairy Division, U. S. Department of Agriculture.

It was found that pure cultures of *bulgaricus* could be used with perfect results in suppressing the undesirable fermentations, principally gas, which have worried Swiss cheesemakers in the past. There seems to be a difference in the efficiency of different strains of *bulgaricus* for this purpose without respect to their activity in forming acid. One per cent. of a whey starter made from one culture was sufficient, while it requires three per cent. of another. The *bulgaricus* starters could not be seen to have any effect on the formation of the eyes or interfere with the flavor or texture. It is believed that the proper use of *bulgaricus* starters will go far towards making a more uniform cheese during the summer months and will make it possible to produce good Swiss cheese during the entire year.

[1] Does not ferment raffinose, glycerine, mannite, inulin, starch.

[2] Liquefaction was slow, in some cases occurring only after a number of months.

The Preparation of Dried Cultures: L. A. ROGERS, Dairy Division, U. S. Department of Agriculture.

The method of Shackell, consisting essentially in holding the frozen material over sulphuric acid in a high vacuum, is adapted for drying cultures of the lactic acid bacteria, *B. bulgaricus* and other organisms. A chamber was devised in which considerable quantities of powder could be made. The best results are obtained by drying cultures grown on milk concentrated to one half its original volume. Fresh lactic cultures dried by this method curdle milk in twenty hours at 30° when one part of powder is added to 1,000,000 parts of milk. Dried cultures of *B. bulgaricus* curdle milk in twenty hours at 37° when added to the milk in the ratio of 1: 100,000. The activity of a dried culture diminishes more or less rapidly, depending on the conditions under which it is held. The deterioration is less rapid if the moisture content is very low; it is less rapid as the temperature of storage is diminished and is much more rapid in air or oxygen than in an inert gas or in a vacuum.

The Normal Bacteria of Swiss Cheese: E. E. ELDRIDGE and L. A. ROGERS, Dairy Division, U. S. Department of Agriculture.

Special media were devised which gave high

counts comparing in a general way with those obtained by dilution in milk. Numerous examinations were made of various cheeses and three domestic cheeses of the Emmenthal type were followed through a nearly complete ripening period. About 1,000 cultures isolated from these cheeses were studied in detail, particularly in relation to their fermentative abilities. It was observed that many of these cultures gave considerable quantities of gas in a sugar-free concentrated whey. It was not possible, however, to separate these cultures beyond three morphological groups, one of which was a long rod, one a short rod and the third a coccus. At the beginning of the ripening the bacterial flora consisted almost entirely of the short rods. The long rods appeared in the early stages of the ripening and increased steadily. The short rods decreased and in each of the three cheeses made up about 50 per cent. of the bacteria at seven or eight weeks, a period corresponding in a general way with the end of the eye formation. Glycerine fermenting cocci appeared in small numbers in each of the cheeses at an age of five or six weeks. At the end of twenty weeks the bacterial flora was composed almost exclusively of the long rods. The essential bacteria of Emmenthal cheese are evidently not ubiquitous. In two widely separated localities cheeses made without inoculation have invariably failed to give the normal fermentation. Cheese made from milk inoculated with a mixture of a large number of pure cultures, or from special culture media inoculated with good cheese, have given uniformly a normal ripening.

Action of a Few Common Butter Organisms upon Casein: Charles W. Brown, Michigan Agricultural College, East Lansing, Mich.

The action of microorganisms upon proteins is looked upon as an aid in identification. If there is an action visible to the sense of sight, liquefaction by that organism is said to be positive, otherwise it is negative. For example, if an organism growing in milk at room temperature for fifteen to thirty days shows no visible digestion, that organism is said to have no action upon casein. This is a mere supposition and in many cases is incorrect. For milk in which such an organism has been growing for several days, if treated with precipitants to remove the unchanged casein, will be found to contain degradation products such as caseoses and peptones. Especially is this true in old milk cultures where the cells of the organisms have died and undergone autolysis, thus liberating an endo-proteolytic enzyme. The power to liquefy casein by liquefiers is either stimulated or retarded to a greater or less degree by four important factors met with in storage butter—addition of salt, diminished supply of free oxygen, low temperature and association with *Bact. lactis acidi.* Now, if we center our observation upon a number of bacteria, found frequently in samples of storage butter, which have no visible action—other than a slight change—upon milk in tubes, within thirty days and make litmus milk agar plates thickly seeded with the organism under observation, we will observe several different pictures presenting themselves. (1) Some of the organisms produce a gradual clearing, noticeable after seven to fifteen days, due to a slow digestion of the casein. (2) If after incubating twenty-four hours at 20° C. the plates are inoculated with *Bact. lactis acidi* by making a stroke on the surface, we see in the case of some of the organisms a rather abundant growth of the lactic with acid production, curdling of the milk in immediate vicinity of the lactic, surrounded by a clear zone and, surrounding the clear zone, a more copious growth of the organism. (3) The same picture with the exception that the growth of the organism is not stimulated. (4) Growth of the lactic about normal, no acidity, the milk in the immediate vicinity of the lactic completely dissolved and surrounded by a more copious growth of the organism. (5) The same except no stimulated growth of the organism. (6) Growth of lactic normal, no acidity, no clearing, but a stimulated growth of the organism. (7) The same except the growth of the organism is not stimulated. (8) Retarded or prevented growth of lactic, no acidity, no digestion and no stimulated growth. A different picture may present itself, if the litmus milk agar plate of the organism is incubated for three to five days before stroking the surface with the lactic, in that the growth of the lactic may be inhibited and that no digestion may occur. Again, if the supply of free oxygen is diminished both before and after stroking the surface with lactic, or if salt is added, or if a lower temperature is used for incubation, different results will be obtained. These organisms, generally spoken of as non-liquefiers, influenced in their action upon casein by different factors can not be overlooked as agents in the degradation of casein in both storage butter and ripening cheese.

A. Parker Hitchens,
Secretary

(To be continued)